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ROENTGENOGRAPHIC RECOGNITION AND DIFFERENTIATION OF PAROSTEAL OSTEOGENIC SARCOMA*

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PAROSTEAL osteogenic sarcoma is an unusual type of primary, malignant, densely ossified tumor of bone that arises and proliferates from a juxtacortical position, thus providing a typical roentgenographic appearance. It is capable of metastasizing and may lead to death. A long life history is characteristic, and distinctive pathologic features are seen. It is the most curable of the primary malignant tumors of bone. Distinction from the usual form of osteogenic sarcoma will be made clear in the following pages.

The slow evolution of knowledge of this tumor is easily explained when one recalls its extremely low incidence and the infrequency with which it is likely to be seen by any one physician in a lifetime. Only with the gradual accumulation of sizable collections of bone tumors in a few large centers has knowledge of this entity increased substantially. Credit for recognition of this group of tumors as an entity goes to Geschickter and Copeland; a series of 16 cases reported in 1951 formed the basis of their study and conclusions. Their concept was that benign and malignant phases of parosteal osteoma may be recognized, the latter phase representing a slowly evolving malignant lesion arising from its benign precursor. The danger of therapeutic procrastination was emphasized by the fact that four of their patients were said to have died of metastasis. They applied the term "parosteal osteoma" to the entire group despite the fact that the

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majority were malignant pathologically.

Dwinnell and associates reported one benign and 14 malignant parosteal osteogenic tumors. The findings of Geschickter and Copeland were largely corroborated. The term "parosteal osteogenic sarcoma" was chosen to describe more clearly the malignant lesions, thereby indicating their foreboding nature and at the same time retaining the descriptive prefix. Dwinnell's group considered that parosteal osteogenic sarcomas were malignant from the outset and probably did not transform to a malignant phase from a benign precursor. Three of their patients died as the result of metastasis from the primary tumor, while one died a few days after operation and a fifth patient died from unknown causes. These 15 patients are included as part of this study and have been subjected to reappraisal.

Coley,[5] Jaffe and Selin, Johnson, Hatcher and others recognized this entity and have stressed certain aspects of its appearance, behavior and treatment. Lichtenstein[15] registered the one dissenting opinion and doubted the presence of malignancy in these tumors.

Several texts, atlases and volumes on skeletal disease[3,4,6,8,10,16] illustrate cases that are most likely representative of parosteal osteogenic sarcomas, but these lesions have been classified under a variety of headings.

MATERIAL

A group of 19 examples of parosteal osteogenic sarcoma was separated from more than 2,300 primary tumors of bone seen at the Mayo Clinic up to May, 1956. Roentgenograms were available for study in 18 cases. A series of films spanning several years of the life history of the tumor were reviewed in most instances. To study the differential features, a review was made of the available films of all roentgenographically related entities, including sclerosing osteogenic sarcomas, osteomas (excluding those of the skull), osteochondromas, myositis ossificans and calcified hematomas. This review embraced several hundred cases.

CLINICAL FEATURES

Typically, the history in parosteal osteogenic sarcoma is not alarming initially. The average patient reports a slowly growing, firm, painless mass that eventually limits the motion of the joint. A dull ache may develop later or the patient may note arthralgia, particularly in changeable weather. Histories of antecedent trauma were obtained in approximately a third of the cases observed at the clinic and those reported elsewhere, but a cause-effect relationship was extremely doubtful.

The patients frequently gave histories of having had the tumor excised one or more times. Each time it was said to be benign but nonetheless it recurred. A predilection for the popliteal space and a tendency to encircle the shaft were common features.

No sex predominance has been observed. The average age of our patients when the tumor was first noted was thirty years. Routine laboratory tests were of no diagnostic help. The prognosis for a patient with this type of tumor is considerably better than that associated with any other primary malignant tumor of bone, for 13 of the 19 patients were alive and well when this paper was written, although six have been followed less than two years. Among the five patients who died from metastasis, the average length of time from recognition of the tumor until death was twenty years, which is a striking contrast to the average survival in other forms of osteogenic sarcoma.

The latest clinical follow-up on these 19 patients with parosteal osteogenic sarcoma indicates the following status. One patient apparently was cured by local excision. Four patients had primary amputation and were alive and well, although three have had follow-ups of less than five years; the fourth has been observed for twelve years. Eight patients were living and well after one or more local excisions

followed by amputation. Six patients were dead after local excisions and amputation.

One of the six deaths occurred postoperatively after reamputation for recurrence in the stump. Local excision had been carried out initially.

Necropsy in another case disclosed generalized metastasis after two local excisions and amputation. The patient died fifteen years after amputation.

Another patient died of metastasis, evident roentgenographically, after three local excisions, disarticulation at the shoulder and removal of the shoulder girdle, each followed by recurrence. A twenty-year period elapsed from recognition of the tumor to death.

After three local excisions and femoral amputation, one patient died of extensive pulmonary metastasis, proved at necropsy. A thirty-year period had elapsed from recognition of the tumor to death. Death occurred six years after amputation.

The fifth patient died twenty-one years after the tumor first was recognized and several years after local excision with recurrence and amputation. Follow-up information indicated that pulmonary and abdominal metastasis was present for several years prior to death.

The remaining patient had two local excisions with recurrence and metastasis. Death occurred five years after recognition of the tumor. Necropsy was not done, but the attending physician stated that cerebral metastasis apparently was present. The affected leg measured 40 inches in circumference at the time of death.

No evidence of a second primary lesion was present in any of the patients who died.

PATHOLOGIC ASPECTS

The tumor in most cases is well delineated and lobular in outline. The cut surface shows compact osseous, fibrous and cartilaginous tissue. A large part of the tumor often can be raised from the outer cortex with a periosteal elevator, leaving only a roughened cortical surface behind. A multitude of tiny particles of yellow material about the size of grains of sand stud the cut surface in most specimens. A few of the gross specimens in our series showed evidence of cortical destruction and medullary invasion, but in most of these instances previous attempts at excision had been made.

This tumor must be classified microscopically as an osteogenic sarcoma because, while the changes may be subtle and of low grade, evidence of a sarcomatous stroma, with regions of metaplasia or transformation into tumor osteoid and bone, is seen. Most experienced pathologists hold that a tumor, the malignant cells of which produce osteoid, should be classed as an osteogenic sarcoma even though fibrosarcomatous and chondrosarcomatous zones may predominate. Both fibrosarcomatous and chondrosarcomatous elements were seen in nearly all the tumors in our group.

As an index of the confusion and inaccuracy that have surrounded this group of tumors in the past, it is interesting to note that the pathologists reported the original lesions as being benign in 14 of the 19 malignant tumors under consideration. Only parts of the bulk of most tumors showed evidence of malignancy and, when found, it was of low grade. This emphasizes the necessity for adequate and sometimes multiple biopsies. Dwinnell and associates noted that the changes of malignancy sometimes became more obvious with each succeeding attempt at excision. With experience, the pathologist's ability to recognize parosteal osteogenic sarcoma increases considerably but the very nature of the tumor, its low-grade subtle malignant changes and the fact that many portions of the tumor are actually benign make his task most difficult.

ROENTGEN DIAGNOSIS

Several features of these tumors stand out roentgenographically. The characteristic site of involvement is long tubular bones in general and the popliteal surface

FIG. 1. Two similar typical parosteal osteogenic sarcomas. Neither tumor showed evidence of cortical destruction or medullary involvement. (*a*) Note the underlying osteomatous reaction. (*b*) The appearance of medullary invasion is produced by partial encirclement of the shaft.

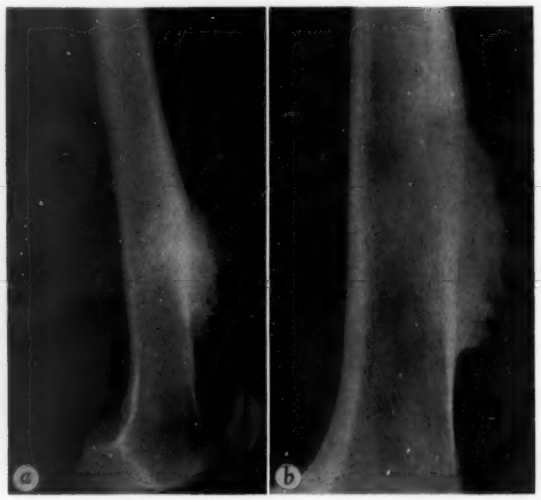

FIG. 2. Parosteal osteogenic sarcoma treated by primary amputation. (*a*) Except for the anterior femoral location this tumor is classic. Note the degree of maturity in the base as indicated by trabeculation. (*b*) Magnified view of the sagittally cut amputation specimen, proving encirclement.

FIG. 3. Three examples of parosteal osteogenic sarcoma. (*a*) Roentgenographically typical tumor showing radiolucent zones of fibrous and cartilaginous tissue within the bulk of the lesion. Note the partial "free space" between tumor and cortex and the uninvaded cortical outline. (*b*) Tumor in a nineteen year old boy with a four year history of an enlarging mass. Stereoscopic films clearly demonstrated the encircling nature and the juxtacortical position of the growth. Material obtained for biopsy from the inferior pole of the lesion in a radiolucent, poorly ossified region gave positive evidence of the nature of the tumor. (*c*) Note lobular outline and relationship of tumor to cortex. Medullary invasion was not apparent at operation. This tumor was excised twice, with subsequent recurrence. The patient died of generalized metastasis eighteen years after this film was made.

of the distal part of the femur in particular (Fig. 1). The tumors in 16 of our 19 cases involved the femur, and the distal part of the femur was the site in all but two of these. The bulk or even the entirety of the tumor is juxtacortical in position; in a majority of cases, it has a most unusual and peculiar tendency to encircle the shaft of the involved bone (Fig. 2 and 3*a*). When one views films taken in anteroposterior and lateral positions, the tumor generally is seen on several surfaces of the shaft. This is best demonstrated by stereoscopic films, which allow one to see clearly the extracortical enveloping nature of the growth (Fig. 3, *b* and *c*). The exact site of origin of the tumor is not certain but its position indicates that it is of cortical or more likely periosteal origin. Typically, it is rather firmly attached to the cortex along a part of its sessile base (Fig. 4) but then it grows peripherally in an enveloping fashion to lie in close proximity, but not attached, to the remainder of the shaft. This latter feature is evident roentgenographically in most cases, in which a partial "free space" of varying length and 1 mm. to 3 mm. in thickness may be seen, generally near one pole or the other of the tumor (Fig. 3*a*).

Fig. 4. This parosteal osteogenic sarcoma was unusual in that cortical break-through was evident at the time operation was first done in 1919. Because of recurrence after excision, midthigh amputation was done two years later. Recurrence in the stump several months later necessitated disarticulation of the hip. The patient died three days later. Note mushrooming of the tumor from its point of attachment. This lesion was the least well ossified of the group.

Fig. 5. Two parosteal osteogenic sarcomas, illustrating variation in appearance. (*a*) Appearance twelve years after tumor was first palpable, amputation having been refused. This patient died eight years later of pulmonary metastasis. (*b*) Original appearance of another tumor. Four attempts at extirpation were made, each followed by recurrence. Amputation was done seven years after the date of this film.

The roentgenographic outline of the tumor is generally lobular or it may have a rolling convex border. Angular projections occasionally extend into the soft tissue but this is rather exceptional (Fig. 5). The density of the tumor lacks uniformity, but its bulk typically is 75 to 90 per cent ossified and rather clearly outlined. Its density generally at least equals that of the adjacent shaft (Fig. 6). Numerous ill-defined and irregular fibrous or cartilaginous inclu-

FIG. 6. Parosteal osteogenic sarcoma. Note lobular border, popliteal location, cortical osteomatous reaction and density of the parosteal growth.

sions are viewed in the substance of the tumor as radiolucent defects. The most densely ossified portion of the tumor is at the base in most cases, while the peripheral portion is obviously proliferating and is somewhat less completely ossified. Longitudinal wavy or convex curvilinear striations of compact ossified tissue form the base in some tumors, whereas an amorphous dense base is seen in others. An underlying osteomatous reaction occurs in the cortex in most lesions (Fig. 6).

The periphery may be made up of a variety of lobules or compartments of osseous tissue of various sizes and in different stages of maturation or differentiation. In three of our malignant lesions, evidence of true trabeculation was seen in some of the lobules, thus indicating the degree of "normalization" that even the periphery of the tumor may undergo. More typically, however, one sees an amorphous osseous arrangement or linear, oblique, crosshatched, radial or irregular striations in the lobules. Formation of perpendicular juxtacortical spicules, such as is seen in osteogenic sarcoma, is most unusual in primary unaltered parosteal osteogenic sarcoma.

A particularly helpful and distinctive roentgenographic feature is the absence of periosteal elevation. It was not seen in any of our cases, nor was it illustrated in any of the previously reported cases. Thus, Codman's angle was conspicuous by its absence. Such a feature is further evidence that the tumor originates from the periosteum. With proper exposure and when viewed in its unaltered form, the cortex appears to be intact and uninvaded in most cases, even though extensive juxtacortical growth is present (Fig. 7). After several months or, more likely, years of growth, the cortex may become invaded and take on a

FIG. 7. Interval films demonstrating growth of a tumor during a seven year period. (*a*) When first biopsied, at the stage shown here, evidence of malignancy was not found. (*b*) Definite evidence of malignancy was obtained at amputation seven years later.

rather shaggy appearance that is accompanied by reactive growth of bone. Erosion through the cortex may take place eventually and the medullary portion is slowly invaded. This does not necessarily negate the good prognosis. Study of right-angle views of the tumor may make one suspect early medullary invasion, but the same tumor can be seen to be juxtacortical when it is viewed stereoscopically.

None of the lesions in our cases and none of those previously reported arose from a pedicle. All had broad bases and were sessile in character. A pathologic fracture would not be expected in a tumor as densely ossified as this and, in fact, was not seen in any case.

Collaboration between radiologist and surgeon in obtaining satisfactory material for biopsy is to be encouraged, for most often the least densely ossified and more peripheral portions containing a minimal amount of amorphous or linear ossification are the most malignant.

Two patients with parosteal osteomatous tumors in addition to the 19 already mentioned are included in this study despite the absence of convincing pathologic evidence of malignancy. Both tumors displayed a pattern that was extremely similar microscopically, however. Roentgenographically, one lesion exhibited a rather homogeneous pattern and crude trabeculation in the bulk of the tumor, both features being slightly atypical of the malignant group and indicating a more benign nature (Fig. 8). Only the films of a recurrent lesion were available in the second case. These showed a dense osteomatous sessile base remaining at the site of excision and a large lobular recurrent tumor in the adjacent popliteal soft tissue. The tumor in the latter patient was excised initially and has recurred twice. The former patient has been followed for several years since partial excision; evidence of proliferation has not appeared. Both cases are so similar to the malignant group from the standpoint of history, roentgenographic findings and pathologic changes that it is thought they should be included in the same general category.

Fig. 8. Parosteal osteoma. This patient has been followed carefully since partial excision three years ago; evidence of further activity has not appeared. Pathologically, the tumor was benign. Roentgenographic evidence of benignancy and differentiation includes the relatively homogeneous appearance and the presence of definite trabeculation, the latter being good evidence of the state of maturation of the tumor.

Appearance of Recurrent and Residual Tumors

Some surgeons, because of an erroneous pathologic diagnosis or the low grade of malignancy reported, will perform local excision of the tumor. Almost without exception, a portion of the tumor, if not a large number of fragments, remains at the site of resection. Because of the circumferential growth of the tumor, complete excision is a most difficult technical task. The

FIG. 9. Changes in a parosteal osteogenic sarcoma during a seven year interval. (*a*) This lateral film was taken prior to excision of the tumor, amputation having been refused. (*b*) This anteroposterior view illustrates the same femur seven years later. Amputation subsequently was done elsewhere. Parosteal regrowth of the tumor, lack of gross medullary involvement and slow progress of recurrence without death are illustrated.

fragments that lie closest to the cortex apparently proliferate most often as the nidus of the recurrent tumor, while the more distant fragments become nonviable. This feature is strikingly similar to the seeding problem seen in chondrosarcoma and suggests that the surgeon should exercise all possible precautions to prevent this occurrence.

Because of the almost universal evidence of residual tumor after attempts at local excision, postexcision films should be taken before the surgical wound is closed to check the thoroughness of the extirpation. From the experience gained at the clinic, local excision has proved to be a poor and sometimes unfortunate substitute for amputation in nearly all cases.

Even after wide local excision, including the cortex at the base of the tumor, little tendency exists for gross medullary invasion when the tumor recurs. Instead, the picture is one of re-formation of the tumor along the site of the excised cortex, followed by external proliferation in the parosteal region until the appearance of the primary tumor is nearly reconstructed; even the free space previously described is sometimes seen. The appearance of the recurrent tumor could be mistaken easily for that of the original tumor in certain cases. In a period of months to years, the recurrent tumor was nearly always of approximately the same density as the primary lesion (Fig. 9 and 10).

DIFFERENTIAL ROENTGEN DIAGNOSIS

From a pathologic point of view, myositis ossificans has been confused more often with parosteal osteogenic sarcoma than

FIG. 10. Recurrent parosteal osteogenic sarcoma. Note density of the recurrent tumor and the propensity for juxtacortical regrowth and encirclement of the shaft. "Complete" excision had been carried out elsewhere one year previously.

has any other lesion. The roentgenographic appearance of myositis ossificans likewise may be confusing at times. Progressive myositis ossificans obviously would not be a differential problem because of the nontraumatic nature of the disease and the multiplicity of lesions. The differential features of myositis ossificans associated with paraplegia and of that form following surgical procedures are too obvious to warrant discussion. Cases of idiopathic or traumatic myositis ossificans in which the lesions have a sessile base and are attached to the shaft of a long bone cause the greatest difficulty in diagnosis. If the lesion is unattached to bone and if its appearance has not been altered surgically, the diagnosis of parosteal osteogenic sarcoma need not be entertained seriously.

The heterotopic bone in myositis ossificans often shows a well-organized and clear-cut trabecular pattern. Such a feature generally is absent in parosteal osteogenic sarcoma. The angular borders and distribution of ossification in the muscle bundles in myositis ossificans are helpful differential roentgenographic features that are not observed in parosteal osteogenic sarcoma.

The lesions of myositis ossificans may assume a pedunculated shape, a feature that is not seen in parosteal osteogenic sarcoma. If the base is sessile, evidence of periosteal elevation may be present as the result of deep trauma and subperiosteal bleeding. The latter feature has not been seen in any of our cases of parosteal osteogenic sarcoma nor was it observed in any of the cases illustrated in the literature. An example of myositis ossificans closely simulating the gross picture of parosteal osteogenic sarcoma is illustrated in Figure 11*a* to demonstrate the resemblance and the differential features of periosteal elevation and subperiosteal formation of new bone. The records of two such patients seen at the clinic have been reviewed; both lesions were biopsied and each was diagnosed as a low-grade osteogenic sarcoma. Present critical pathologic review of this tissue discloses no true evidence of malignancy and it is now considered that these cases represent myositis ossificans or "pseudo" osteogenic sarcoma.[17] A clue to the true identity of such lesions may be obtained from the rapidity of growth and the time of appearance after trauma. The lesions in myositis ossificans, such as the two cases just mentioned, generally are palpable soon after trauma. They enlarge rather rapidly to a self-limiting size, after which the patient usually notes that they have become firmer. Evidence of ossification customarily is seen roentgenographically within two to six weeks. By contrast, parosteal osteogenic sarcoma generally is extremely firm when first noted; roentgenographic evidence of ossification is obvious from the first and the tumor slowly continues to grow larger.

Fig. 11. (*a*) Myositis ossificans. This patient gave a history of trauma forty-one days before this film was made. A pathologic diagnosis of osteogenic sarcoma had been made on biopsy elsewhere. Excision at the clinic revealed a diagnosis of myositis ossificans. Note the periosteal elevation, which is not found in parosteal osteogenic sarcoma. (*b*) Osteochondroma. Note how both the spongiosa and the cortex sweep into the base of the tumor. Such a lesion rarely encircles the shaft.

A solitary broad-based osteochondroma doubtlessly is the commonest differential problem. In fact, 11 of the parosteal osteo-

FIG. 12. Two views of a sclerosing osteogenic sarcoma. Such tumors usually show cortical destruction, periosteal elevation and Codman's angle, which distinguish them from parosteal osteogenic sarcoma. These features are evident in this lesion.

genic sarcomas in our series were diagnosed roentgenographically in the past as being osteochondromas. Most osteochondromas of tubular bones are pedunculated, but in all, whether pedunculated or sessile, the cortex and spongiosa of the adjacent normal bone may be seen to sweep into the base of the tumor (Fig. 11*b*). These features are absent in parosteal osteogenic sarcoma, as are the cartilaginous inclusions containing dense clumps of calcification characteristically found in osteochondroma. Most broad-based osteochondromas are not so completely ossified as are parosteal osteogenic sarcomas. Another important differential feature is the lack of encirclement of the shaft by osteochondroma. Review of the films in more than 100 surgically proved cases of osteochondroma placed our findings in complete agreement with those of Bloodgood, who studied the roentgenograms in about 100 cases of benign exostoses and different types of benign ossifying periostitis and found that it was extremely rare for the new growth of bone to encircle the shaft in these conditions.

The sclerosing type of ordinary osteogenic sarcoma theoretically should be a differential problem but in actuality this lesion usually can be distinguished without difficulty. While a sclerosing osteogenic sarcoma may extend into the juxtacortical soft tissue, it originates centrally and must destroy the cortex to extend into that position. In the vast majority of cases, cortical destruction, extensive medullary involvement and Codman's angle are seen (Fig. 12). An ill-defined border, periosteal elevation and ossification of a comparatively small portion of the bulk of the soft-tissue mass likewise tend to distinguish this lesion from parosteal osteogenic sarcoma.

True osteomas of the skeleton, excluding the calvarium, are among the rarest of all tumors of bone. Two such lesions are mentioned to emphasize their distinguishing features. One was located in the left eighth rib and the other was in the proximal portion of the right tibia (Fig. 13). Roentgeno-

FIG. 13. Two views of a tibial ivory-like parosteal osteoma. The similarity to parosteal osteogenic sarcoma is obvious; however, the pronounced homogeneous density is the distinguishing feature. No evidence of malignancy was found. Osteomas of tubular bones are among the rarest of bone tumors.

graphically, both lesions simulated parosteal osteogenic sarcoma in that they appeared to arise from the cortex, grew juxtacortically and tended to encircle the shaft. The medullary portion of the bone in both cases was intact. They differed roentgenographically from the parosteal osteogenic tumors described herein in that they were of uniform ivory-like density throughout, with clearly delineated borders. No evidence of fibrous or cartilaginous islands, such as already described, was seen in these two lesions. Their density was strikingly similar to that of osteomas of the skull. The specimens could be sawed only with considerable difficulty owing to their compactness and density. Microscopically, both were dense osteomas. These two cases are mentioned particularly because it appears that such cases represent the key to whether the clinician ever can temporize justifiably with a parosteal osteomatous lesion. Only time would have determined whether these lesions would have assumed clearly malignant characteristics. Both tumors were widely excised and neither has recurred. Wide local excision appears to be reasonable treatment in such cases on the basis of our experience with these two patients, plus the roentgenographic and pathologic evidence of benignancy.

An ossifying hematoma occurring in juxtaposition to the shaft may produce a confusing picture. It can be distinguished by the presence of periosteal elevation and clumps of ossification and calcification, plus its failure to encircle the shaft. As the original hematoma becomes calcified or ossified, it becomes smaller and firmer, whereas parosteal osteomas maintain a fairly uniform consistency and steadily enlarge. The clinical history obviously would be of substantial aid in such differentiation.

While exuberant callus subsequent to a fracture is a theoretic differential problem, fractures have not been seen or reported in parosteal osteogenic sarcoma. The presence of the free space, the lobular outline and the lack of uniformity of the ossified mass would be evidence against callus. Exuberant callus is said to be a feature of fractures in osteogenesis imperfecta;[1,14] in all such cases illustrated, however, evidence of the systemic skeletal disease is obvious.

COMMENT

The foregoing comments concerning the unreliability of pathologic diagnosis should not be misconstrued to mean that one should make no effort to obtain microscopic confirmation of the diagnosis. On the contrary, every effort should be made to do so. The problem arises when histopathologic evidence of malignancy is lacking in the face of a typical history and characteristic roentgenographic findings of parosteal osteogenic sarcoma. Under these circumstances, we believe that the roentgenographic diagnosis is reliable enough to warrant serious consideration of amputation on this evidence alone when the roentgenographic appearance is typical. It is fully realized that to rely on the roentgenographic diagnosis to such a great extent in the usual forms of malignant tumors of bone is to invite frequent error. It is only in parosteal osteogenic sarcoma that the roentgenographic appearance is so faithfully reproduced in each case, thus allowing greater reliance to be placed on its features. If reasonable doubt as to the diagnosis exists and if the roentgenographic appearance is atypical, local excision might be attempted, to be followed by amputation if and when the first sign of recurrence is noted.

Up to the present time, tumors in this group have not been seen or reported in flat bones. If such an event should occur, it is reasonable to expect that the roentgenographic appearance may be different from that described.

As already mentioned, included in this review are 19 cases of parosteal osteogenic sarcoma, two cases of a strikingly similar tumor without conclusive microscopic evidence of malignancy and two cases of parosteal ivory osteoma. It is concluded that the latter two lesions should be con-

sidered benign and the rest malignant. One might view this group of 23 cases as the spectrum of lesions in this category, with benignancy at one end and malignancy at the other. Whether the potentiality for malignancy is present in all such tumors from the outset or arises at some later point in the life history is debatable and undetermined thus far.

SUMMARY

A study has been made of 19 cases of parosteal osteogenic sarcoma encountered at the Mayo Clinic. Particular emphasis has been placed on the roentgenographic aspects of this tumor.

Parosteal osteogenic sarcoma is an unusual type of primary, malignant, densely ossified tumor of bone arising and proliferating juxtacortically. The main distinguishing roentgenographic characteristics are the encircling, dense, lobular and juxtacortical nature of growth, the failure of the lesion to destroy the cortex, the heterogeneity of ossification and the failure to produce periosteal elevation. The presence of a thin free space between tumor and cortex is often seen with the proper degree of obliquity of the view.

Recurrence of the tumor after local excision is almost universal, which is similar to the seeding problem encountered in chondrosarcoma. The tumor usually reforms in the image of the primary lesion.

The differential diagnosis of roentgenographically similar lesions includes consideration of such entities as myositis ossificans, osteochondroma, parosteal ivory osteoma, sclerosing osteogenic sarcoma, ossifying hematoma and exuberant callus.

Careful correlation of the history, roentgenographic features and pathologic characteristics is unquestionably the best method of diagnosis. However, when pathologic confirmation is lacking, the roentgenographic features in typical advanced cases are considered to be reliable enough to base treatment on this diagnosis alone.

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FLUORIDE OSTEOSCLEROSIS*

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TEMPLE, TEXAS

IN ABOUT 1908, McKay and Black[11] of Colorado Springs, Colorado began to note mottling of teeth in some of their dental patients. Astute observations and correlation of facts led them to believe the mottling was associated with the city's water supply, and they published their report in 1916. United States Public Health workers, notably led by Dean[2] and other investigators, have proved since that excessive fluorides in drinking water can cause mottled dental enamel, provided there is long exposure during the tooth formative period in childhood.

By means of detailed epidemiologic studies,[3,4,5] it has been determined that when drinking water contains more than 2 parts per million (ppm.) of fluorides, dental fluorosis will be common but dental caries markedly lessened. When the fluoride content is about 1 ppm., however, mottling is not noted and dental caries is reduced by almost two-thirds. In other words, children drinking water containing 1 ppm. of fluorides during their tooth formative period (birth to eight years) have much less dental decay than those whose drinking water contains no fluorides. As the results of these studies became known, many leading scientific groups[7] endorsed the mechanical addition of fluorides to public water supplies to bring the concentration up to 1 ppm. In 1945, Grand Rapids, Michigan, was the first city in the United States to accept these recommendations and fluorides were added to the water supply. By 1955, there were 1,066 communities with a total population of 20.45 million receiving added fluorides in their drinking water while, for many years, more than 1,000 communities had been using naturally fluoridated water varying from trace amounts to as high as 16 ppm.[8]

Opposition to the addition of fluorides to drinking water developed in some areas, and public opinion was swayed to defeat this procedure at the polls in many instances. Aside from food fadists and other nonmedical opposition, probably most objections took root from Roholm[12] who reported extensive osseous changes in cryolite (Na_3AlF^6—54.3 per cent fluorine) workers who inhaled this dust for many years. There also have been a few case reports[1] of osseous changes developing in rock phosphate (about 4 per cent fluorine) workers who inhaled this dust for considerable periods of time.

In an effort to evaluate possible systemic changes due to long term ingestion of excessive fluorides in drinking water, the Public Health Service of the United States Department of Health, Education, and Welfare began a careful survey of the adult population of Bartlett and Cameron, Texas, in 1943 and repeated the study ten years later in 1953.[9] Bartlett and Cameron are two central Texas towns about 25 miles apart. Cameron's drinking water contains no fluorides, while Bartlett's averages 8 ppm. To qualify for the survey, the individual had to reside in the community and drink water from the public water supply for at least fifteen years prior to 1943. Approximately 80 per cent of the participants in the original survey were examined again in 1953, a complete history and physical examination plus numerous blood and urine studies being obtained. Roentgenograms were made of the spine and pelvis, and in many instances there were complete skeletal surveys. The published conclusions of the combined ten-year study were: "Dental fluorosis developed in all Bartlett residents who ingested the community water during their tooth formative period.

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There were no clinically significant physiologic or functional effects resulting from prolonged ingestion of drinking water containing excessive fluorides." In the roentgenologic study of the same group of individuals in Bartlett and Cameron,[10] it was concluded that: "Excessive fluorides in drinking water may produce roentgenographic evidence of bone changes, but the observable changes (1) occur in only 10 to 15 per cent of all those exposed over a period of many years; (2) are slight, often difficult to recognize, and in most instances equivocal in degree; (3) bear no resemblance to the bizarre findings described in some cases of long exposure to cryolite or rock phosphate dust, or to those attributed by some investigators to excessive fluorides in drinking water; (4) are not associated with other physical findings, except for dental mottling in persons who reside in the high fluoride area during their tooth formative period; (5) cannot be ascribed to excessive fluorides alone; (6) do not necessarily occur even though the fluoride content of the bone may be six times that of normal bone."

While there have been numerous reports of experimental work with excessive fluorides in laboratory animals, very few authentic case reports dealing with systemic changes in humans are to be found in the medical literature. Other than the reports made by the Public Health Service, very little has been done in actual survey of whole populations with systemic effects in mind. Hodges and his associates[6] surveyed two Illinois towns where the fluoride content of the drinking water varied from 1.2 to 3.0 ppm. They found no evidence of fluoride sclerosis even in those residents exposed for many years. They concluded that, as far as these two towns were concerned, up to 3.0 ppm. of fluorides caused no detectable systemic osseous changes in the individuals examined.

Independently of the Public Health Service survey, and in order to evaluate further the systemic effects of excessive fluorides in drinking water, we reviewed the medical records on file at the Scott and White Clinic for the eleven year period from 1943 through 1953. A roentgenologic diagnosis of fluoride osteosclerosis was recorded on 23 patients' records. No cases reported by the United States Department of Health, Education, and Welfare are included. In spite of the fact that we were "fluoride osteosclerosis conscious" due to our participation in both Public Health Service studies of Bartlett and Cameron residents, we were able to find only this small number of cases from a total of approximately 170,000 roentgen examinations of the spine and pelvis. These spinal and pelvic roentgenograms were made on patients primarily from Texas and Oklahoma. In Texas, there are over 270 communities having a water supply containing 0.7 ppm. or more of fluorides; while in Oklahoma, there are more than 50 such towns.

Our group of 23 patients presented nothing in common except roentgenographic changes in their osseous systems. All patients were given complete clinical examinations including serology, sedimentation rate, red and white blood cell counts, differential white blood cell count, hemoglobin, blood urea, and routine urine studies. Because of their advanced age, most patients had electrocardiographic investigations. Healed bone fractures were reported by 4 patients. Two fractures occurred during childhood and healing was prompt. One patient, eighty-five years old, fractured her right hip two years before admission to the clinic and the other patient, aged sixty-five, reported a similar fracture. The clinical laboratory tests yielded no results which could not be explained on the basis of the final clinical diagnosis. The physicians who examined these patients were familiar with dental fluorosis, but they were unable to determine any relationship between the roentgenologic findings and the patients' disease processes or symptoms. Considering the advanced age of over half of our series of patients, there was no unusual incidence of anemia, arteriosclerosis, arthritis, back stiffness, renal

disease, or biliary calculi. Ten years before admission to the clinic, one patient was told that she had "leukemia of the bone" and that she would not live much longer. At the last report, she was well, has had no abnormal blood changes, but does have the roentgenologic findings of fluoride osteosclerosis. No instance of Marie-Strümpell arthritis was observed.

Since no clinical correlation or significance could be attached to the roentgenologic findings, the validity of the roentgen diagnosis of fluoride osteosclerosis may be questioned. In this series of 23 patients, there was no chemical analysis of bone for fluorine content. The diagnosis was based on bone changes as reported by Roholm, bone changes we have observed in cattle exposed to extremely high toxic doses of fluorides, and on bone changes noted in a few Bartlett, Texas, residents who were examined during the Public Health Service surveys. Leone and co-workers have reported the complete autopsy findings of a patient from Bartlett who had typical roentgenographic findings of fluoride osteosclerosis, the chemical analysis showing approximately six times the normal amount of fluorides. This information, plus the fact that this group of 23 patients had been drinking water with a high fluoride content for many years, permits us to assume that the diagnosis is correct, especially since we have not observed these changes in individuals not exposed to fluorides.

Table 1 shows that the osseous changes were noted in our series of 23 patients with fluoride osteosclerosis only when the drinking water contained a fluoride content of from 4 to 8 ppm. Each of these patients had lived his entire life in the same fluoride bearing area in which he was born. We have attempted to grade the osseous changes on the basis of a 1 to 4 scale, with grade 1 showing bone density of a very minimal degree, and grade 4 showing bone density of an extreme degree. Pelvic ligament calcification was graded also on the basis of the 1 to 4 scale, with grade 1 representing minimal calcification in either the sacrotuberous or sacrospinous ligaments, and grade 4 showing calcification extending about 6 cm. from the ischium towards the sacrum. It will be noted from this table that 15 of the 23 patients had this type of ligamentous calcification and that it closely paralled the degree of bone density.

Table 1

FLUORIDE OSTEOSCLEROSIS

Case	Age	Parts per Million Fluorides	Degree of Fluorosis	Pelvic Ligaments
1	83	8.0	4	0
2	50	8.0	1	1
3	85	8.0	1	0
4	55	8.0	1	1
5	66	7.6	2	2
6	67	7.6	4	4
7	72	7.6	3	2
8	73	5.4	4	1
9	66	5.4	4	0
10	67	5.4	4	0
11	57	5.2	3	2
12	50	5.2	4	1
13	62	5.0	4	4
14	46	5.0	1	0
15	79	4.0	4	4
16	50	C.T.*	1	1
17	58	C.T.*	4	1
18	48	C.T.*	1	0
19	44	C.T.*	1	0
20	80	C.T.*	4	4
21	44	W.T.†	1	2
22	63	Okla.‡	4	4
23	62	Kan.§	1	0

* Patients were central Texas farmers who moved several times, but drank water from shallow wells in known fluoride areas. Exact ppm. not known.

† Same as above, but lived in West Texas.

‡ Same, but lived in Oklahoma.

§ Same, but lived in Kansas.

The roentgenologic diagnosis of fluoride osteosclerosis is based primarily on Roholm's observations in patients exposed to very large doses of fluorides inhaled as cryolite dust. Roholm found the earliest changes to occur in the pelvis and the spine and to consist of slightly increased bone density with roughened and blurred trabeculae. In the more advanced stages, the bone density increases until some areas appear structureless, the ribs and extremities are involved slightly, and ligamentous calcification ap-

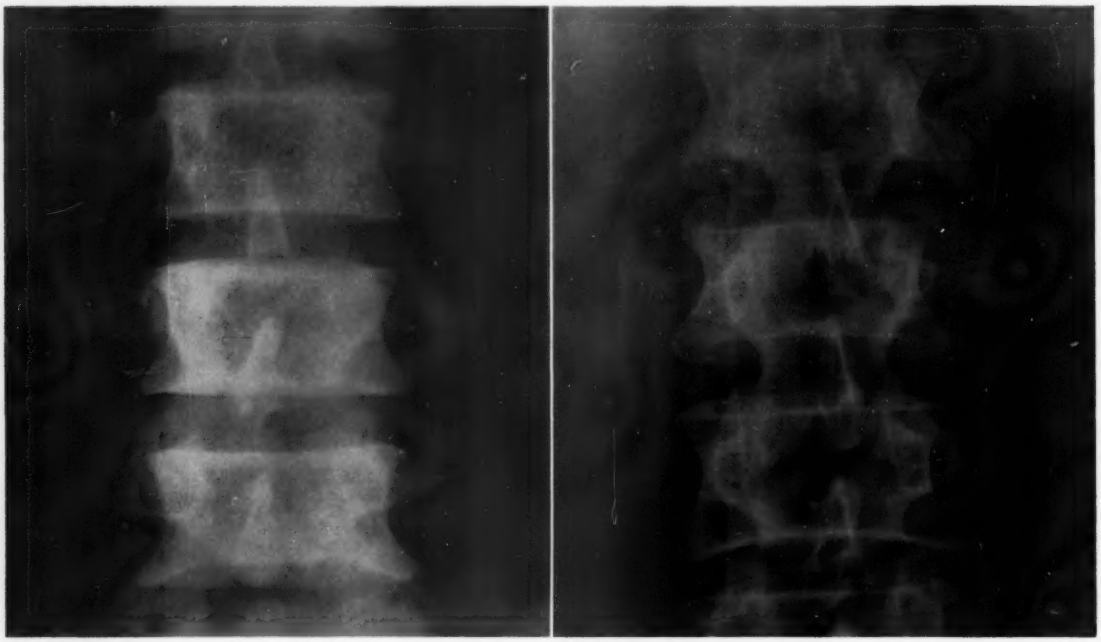

Fig. 1. Case 5. Grade 2 density in the lumbar spine. Note the even distribution and ground glass appearance. Normal spine for comparison.

pears. Our roentgenographic experience with bone changes, noted in the Public Health Service surveys and in this group of 23 patients, has been that the earliest changes do occur in the pelvis and lumbar spine. These changes consist of slightly increased bone density, always evenly distributed throughout the vertebral bodies, and appearing bilaterally and symmetrically in the pelvis. There is a definite but slight "ground glass" appearance. The most advanced changes we have observed consisted of a chalky-white appearance of the vertebral column and pelvis plus a slightly increased density and coarse trabecular pattern in the ribs. The skull or extremities have not shown changes except for slight periosteal roughening in the forearms or legs of a few patients. Involvement of the hands or feet has not been noted. In

Fig. 2. Case 7. Grade 3 density evenly distributed throughout the pelvis. Grade 2 ligamentous calcification.

Fig. 3. Case 13. Grade 4 density and grade 4 sacrotuberous ligament calcification.

no instance has there been cortical thickening or increased bone size.

Of special interest is the calcification of the sacrospinous and sacrotuberous ligaments. We have been unable to associate hypertrophic changes in the spine with fluoride changes, but calcification of these pelvic ligaments seems to occur only in those patients with other fluoride osseous changes. The calcification begins at the ligamentous attachment in the pelvis, is usually bilateral and extends towards the sacrum for distances up to 6 cm. The entire length of the ligaments does not calcify, and no instance of calcification at the sacral end of the ligaments has been observed. Because of the nature of this type of sclerotic process with associated pelvic ligament involvement and the absence of any abnormal blood changes, the differential diagnosis of fluoride osteosclerosis from other diseases producing increased bone density is not difficult.

Fig. 4. Case 15. Typical ligamentous calcification with grade 2 density of the pelvis.

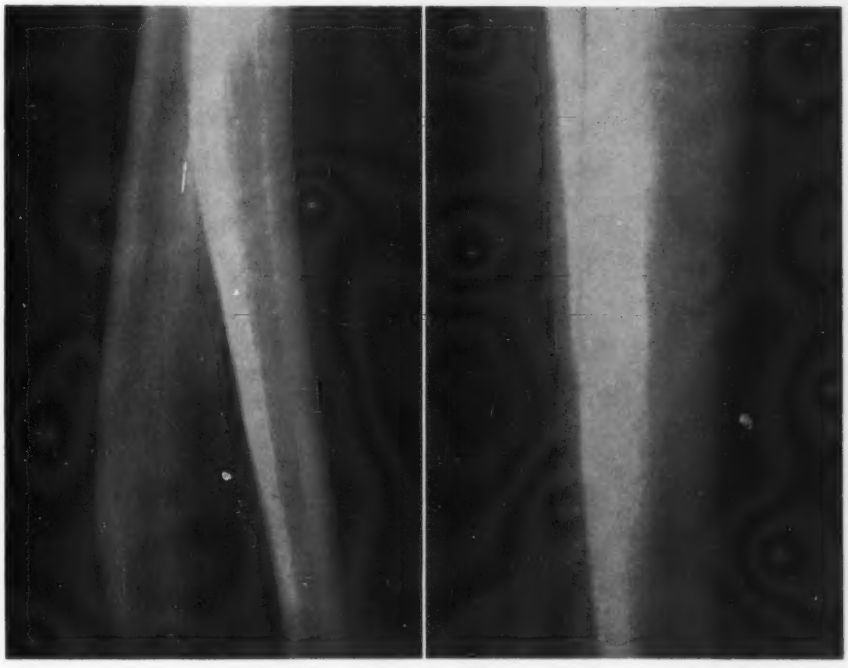

Fig. 5. Case 6. Periosteal roughening in the forearm and leg of this patient who had grade 4 changes in the spine and pelvis.

CONCLUSIONS

1. Twenty-three cases of fluoride osteosclerosis are presented.

2. These cases were gathered from 170,000 roentgenographic examinations of the spine and pelvis of patients living in Texas and Oklahoma where many communities have excessive fluoride content in their drinking water.

3. In each case, adequate clinical examination failed to establish any relationship between the roentgenologic findings and the clinical diagnosis of the patient's condition.

4. Fluoride osteosclerosis, developing in the patient exposed over a period of many years to fluorides as high as 8 ppm., causes no harmful changes.

5. Fluoride osteosclerosis is not evidenced roentgenographically in the patient drinking water with a fluoride content of less than 4 ppm.

6. In the patient presenting roentgen evidence of sclerosis of the bone, calcification of the sacrospinous and sacrotuberous ligaments is a distinct aid in the diagnosis of fluoride osteosclerosis.

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IDIOPATHIC HYPERCALCEMIA*

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IN 1952 Fanconi and Schlesinger, with their associates,[6] each reported a case of idiopathic hypercalcemia with osteosclerosis, azotemia, retarded development and congenital malformations. Five further cases have been described since then by Creery and Neill,[2] Dawson and Craig,[5] Lowe and co-workers,[9] Fanconi,[7] and Naylor,[15] the last case being also a cretin. Four more cases, including one cretin, which showed well the striking and characteristic roentgenographic changes associated with this condition, are to be described here.

REPORT OF CASES

CASE 1. G. T., a white male, was admitted to the Children's Medical Center, Boston, at the age of two and one-half years because of severe anorexia and weight loss. He first came under medical care at the age of four weeks when he was operated on for hypertrophic pyloric stenosis. He made a good recovery at the time, but when he was six months old persistent vomiting recurred with severe weight loss. Another operation for the relief of constricting duodenal bands was carried out at eleven months.

His health continued to be unsatisfactory and at sixteen months he was again admitted to the hospital where he was found to be suffering from chronic renal insufficiency. Roentgenograms at this time are reported to have shown general bony decalcification with transverse densities at the ends of the long bones.

From then on his condition fluctuated until the age of two and one-half years when, following an attack of pertussis, his symptoms became markedly exacerbated. He refused all food and, having lost 3 pounds in three months, was admitted to the Children's Medical Center.

His parents were both alive and healthy. He had one sibling who is since said to have become ill with evidence of mental and physical retardation and renal damage. Unfortunately it has been impossible to obtain further details as to his condition. Pregnancy and delivery were normal. He had been given vitamin D but never in amounts larger than the usual prophylactic dose. There was no history of ingestion of harmful substances.

Examination revealed a very irritable listless child. Hypotonia was most marked and he was noted to make constant waving motions with his hands without moving his arms, as if he lacked the strength to do so. He was physically and mentally retarded, both weight (24 pounds, 2 ounces) and height (32 inches) being below the third percentile. He had never been able to stand and although he did speak words at the age of one and one-half years, at the age of four and one-half years he was only able to say simple sentences. His pulse was 150, blood pressure 128/94, respiratory rate 30. Electrocardiograms revealed a sinus tachycardia. No murmur was noted at this time but at the age of four and one-half years a grade II, blowing systolic murmur was present.

Laboratory investigations revealed hypercalcemia, renal impairment with a high nonprotein nitrogen and compensated acidosis. Findings were: Urine, specific gravity 1010, pH 5.5, some albumin, no pus. The Sulkowitch test for calcium was positive. Blood cell counts were normal, nonprotein nitrogen 69.2 mg., pH 7.35, carbon dioxide 18.7, calcium 14.0 mg., phosphorus 6.7 mg., phosphatase 6.9 Bodansky units.

Roentgenograms showed widespread increase in bone density and soft tissue calcification (Fig. 1–4). The skull (Fig. 1) showed an amorphous increase in density, particularly in the basal and frontal regions and the jaws. In the epiphyses and round bones, the increase in density was either amorphous or in concentric layers of varying density, corresponding to the manner in which growth takes place in these bones. The long bones (Fig. 2) showed multiple bands of sclerosis 1 cm. or less apart lying parallel to their growing ends and shading

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Fig. 1. Case 1. Generalized amorphous osteosclerosis in skull. Calcified carotid artery.

off gradually into the less dense areas in between. Their trabecular pattern was undisturbed; their cortical bone was normal or slightly thinned. In addition to variations in density, the long bones showed some failure of tubulation and a curious cupping of their growing ends. The shafts of the radii and ulnae (Fig. 3) were deformed as if they were softer than normal and had been distorted by muscular action.

Extensive soft tissue calcification was seen particularly in the peripheral arteries. This was quite marked about the wrists, right knee, and in the internal carotid artery. Calcification was also present in the soft tissues of the shoulders, hips and forearms, apparently in the fascial planes. The bronchi were very heavily calcified and deposits were also seen in the vasa deferentia and basal ganglia.

The patient's bone development was normal for his age. The cranial sutures appeared normal. The muscle masses were definitely smaller than usual, particularly in the lower limbs. The renal outlines were small and irregular, but no definite nephrocalcinosis could be demonstrated.

The patient was sent home on a low calcium diet and given aluminum hydroxide and cremalin to reduce his phosphorus intake. Progressive renal deterioration continued to take place,

Fig. 2. Case 1. Long bones showing multiple bands of increased density, undertubulation and indentation of growing ends.

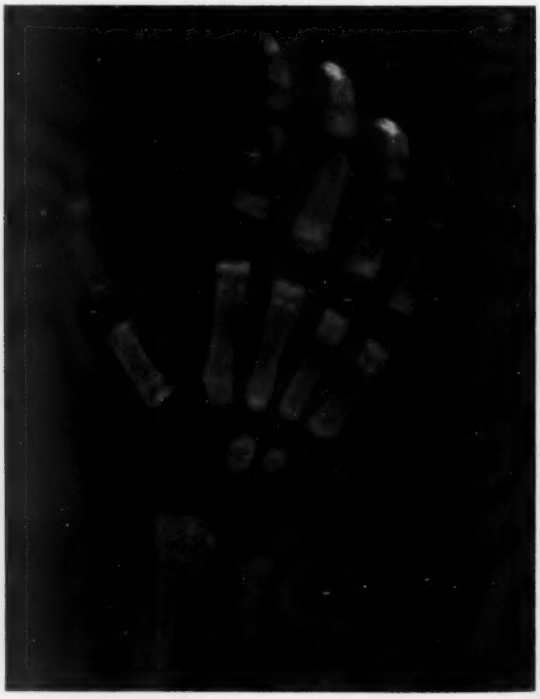

Fig. 3. Case 1. Transverse and annular bands of varying density in long and round bones. Bowing of radial and ulnar shafts. Calcified radial artery.

however, and at the age of four and one-half years he was readmitted with uremia and died. Permission for an autopsy was refused.

Case II. A. S., a white female, was first seen at the age of seventeen months suffering from such severe muscular weakness that at first a diagnosis of convalescent poliomyelitis was considered. On detailed inquiry, however, a history of anorexia, vomiting, and failure to thrive since the age of six months was obtained. The mother also volunteered the information that the child was always wet and frequency of micturition was confirmed in the hospital.

Both parents were alive and well and no relevant family history was obtained. Pregnancy and delivery were normal. No history of excessive intake of vitamin D or other toxic substances could be obtained.

Examination revealed a small, poorly developed, wasted and somewhat dehydrated child. She was irritable and extremely hypotonic. She made constant waving movements with her hands but not her arms. Although she followed a bottle with her eyes and cried for it, she never attempted to reach for it, as though she lacked the strength to move her arms. Physical retardation was marked, both height (75 cm.) and weight (15 pounds) being below the third percentile. Her mental development was difficult to assess because of her extreme muscular weakness, but it was thought to be considerably retarded; she was unable to sit, talk or crawl.

Fig. 5. Case II. Typical "elfin" facies.

Fig. 4. Case I. Generalized osteosclerosis.

Her facial appearance was unusual, as can be seen from Figure 5, and bore a considerable resemblance to the "elfin" facies described by Lowe and Fanconi in their patients. As may be seen, her forehead is wide in proportion to her lower face, which appears pointed. Her eyes are prominent, her lips large and coarse, and her ears large and unusually low set.

Examination of her cardiovascular system revealed a pulse rate of 132, respirations 24, blood pressure 112/60, and a grade II soft blowing, systolic murmur at the upper left sternal border.

Laboratory examinations revealed renal damage and intermittent hypercalcemia. At times, the serum calcium fell as low as 8.5 mg. per cent, but values higher than 12.5 mg. per cent were obtained repeatedly and on one occasion it reached 14.0 mg. per cent. Findings were:

FIG. 6. Case II. Cupping of ends of long bones resembling rickets. Osteosclerosis and undertubulation.

Urine, specific gravity 1012, pH 6.7–7.0, with albumin and pus present; blood cell counts were not significant, hemoglobin 10.4 gm., nonprotein nitrogen 74.2 mg. per cent, calcium 12.8 mg. per cent (range 8.5–14.0 mg. per cent), phosphorus 6.7 mg. per cent, alkaline phosphatase 4.9 Bodansky units.

Roentgenograms revealed generalized osteosclerosis. The skull showed an amorphous increase in density, particularly in its base. No true craniosynostosis was apparent, but the sutures were perhaps less prominent than is usual at eighteen months of age. The vertebrae, epiphyses and carpal bones showed an amorphous increase in density. The long bones showed ill-defined bands of increased density parallel to their growing ends associated with some coarsening of the trabeculae but no disturbance of their pattern. The cortex was not involved.

The kidneys were small and appeared increased in density probably because of fine calcium deposits in their substance. No other ectopic calcification was demonstrated.

Slight failure of tubulation was apparent in the long bones, particularly at the wrists and knees. The growing ends of the long bones showed marked cupping; the epiphyses appeared to have been pushed into the diaphyses at the knees and resembled rickets at the wrists (Fig. 6). Bone development was markedly retarded, the bone age, according to Pyle and Greulich's standards, being nine months against a chronologic age of seventeen months.

The patient was sent home on a diet low in calcium and vitamin D and given sodium phytate 1 gm. per day to reduce calcium absorption. When last seen at the age of twenty-two months, she had better motion, had gained weight and was considered by her parents to be much improved.

CASE III. J. G., a white male, was seen at the age of two years because of delayed development. He had a history of repeated pulmonary and urinary infections with anorexia, vomiting and failure to thrive since he was six weeks old. The family history was not significant. Pregnancy and delivery were normal. There was no history of excessive dosage with vitamin D or other toxic substances.

Examination revealed an extremely weak, hypotonic, irritable child, markedly retarded both physically and mentally. His weight was 13½ pounds, below the third percentile. He could not sit and even at the age of three and one-half years when he was last seen he could only say a few words.

Laboratory investigations revealed hypercalcemia, secondary anemia and renal damage. The findings were: Urine, specific gravity 1010, reaction acid, albumin, pus and casts being present. E coli was obtained on culture. Blood, secondary anemia, nonprotein nitrogen 60.5 mg. per cent, calcium 13.2 mg. per cent, phosphorus 4 mg. per cent, phosphatase 2.9–3.4 Bodansky units.

Roentgenograms revealed marked retardation of bone development, his bone age being one and one-half years against a chronologic age of two and one-half years. His long bones (Fig. 7) were markedly overtubulated and slender and his muscle masses extremely small.

This was probably a result of disuse due to the very marked general muscular hypotonia and weakness. The ends of his long bones were cupped, the changes being indistinguishable from those of rickets, and their cortex was unusually thin. Generalized osteosclerosis was present, amorphous in the skull, in the form of coarsened trabeculae in the vertebrae, and in bands, transverse in long bones and circular in round bones and epiphyses elsewhere. It is of interest that some of the most heavily sclerosed bone was that laid down in utero (see the distal femoral epiphyses in Figure 7). Extremely extensive nephrocalcinosis was present (Fig. 8). No other soft tissue calcification was demonstrated.

When last seen at the age of three and one-half years, he looked like a child of eighteen months. He was still unable to sit or say more than a few words. The roentgenograms showed some slight improvement in the bones, but the renal calcification was, if anything, more extensive.

Fig. 7. Case III. Underdevelopment of bones and muscles. Osteosclerotic bands. Cupping of growing ends resembles rickets.

Fig. 8. Case III. Widespread osteosclerosis with thickened trabeculae. Very extensive nephrocalcinosis.

Case IV. C. H., a white female, was brought to the Children's Hospital at the age of four years and eight months because of her failure to develop. The clinical picture was that of severe hypothyroidism but the roentgenographic findings suggested hypercalcemia as well and laboratory investigations confirmed this.

The family history was not relevant. Pregnancy was normal, but delivery required the use of forceps and resulted in fractures of both clavicles and extensive bruising of the soft tissues of the neck. She appeared well until the age of six months when abdominal distention and constipation developed. The diagnosis of cretinism was made at this time. Thyroid extract was discontinued after it produced symptoms of severe hyperthyroidism. Since then she failed to develop normally. There was no history of excessive vitamin D intake.

FIG. 9. Case IV. Skull of cretin with hypercalcemia.

Examination revealed a cretin with extreme physical and mental retardation. She weighed 21 pounds; below the third percentile, and could not walk, talk or sit. She was hypotonic and extremely lethargic. Apart from hypothyroidism and some widening of the QRS interval in her electrocardiogram, the physical examination was negative.

Laboratory investigations revealed a basal metabolic rate of 50 per cent of normal on the basis of weight and hypercalcemia. Findings were: Urine, specific gravity 1016, reaction acid, a trace of albumin, and no pus. Blood, secondary anemia, nonprotein nitrogen 30 mg. per cent, calcium 13.0 mg. per cent, phosphorus 4.0 mg. per cent.

Roentgenograms showed her bone development to be that of a child of six months or less. Very heavy osteosclerosis was present, particularly in the skull in both cranial and facial bones (Fig. 9). All bones were affected and bands of varying density were seen, transverse in long bones and ring-like in vertebral bodies (Fig. 10). The bone cortex appeared normal for a cretin, the trabeculae coarsened but not deranged, amorphous increase in density was seen in the skull and elsewhere. The ends of the long bones were markedly cupped and faded off towards their growing ends, the appearances being indistinguishable from healing rickets. The distal tibiae were slightly bowed. Extremely extensive nephrocalcinosis was apparent. No other abnormal calcification was seen.

The patient was given $\frac{3}{4}$ gr. thyroid extract each day. There was some reaction initially but when last seen she appeared, and was considered by her parents, to be definitely improved although still very helpless and impaired mentally.

CLINICAL FEATURES

The manifestations of idiopathic hypercalcemia fall into three groups: those directly due to the raised serum calcium level; those due to changes in organs damaged by prolonged hypercalcemia; and possibly certain associated abnormalities, which tend to occur in these patients but cannot be directly related to hypercalcemia.

The high calcium level is probably di-

FIG. 10. Case IV. Impaired, retarded bone development due to hypothyroidism. Sclerosed, cupped growing ends due to hypercalcemia.

rectly responsible for the marked muscular weakness and hypotonia which was seen in all our cases and noted in all those described in the literature. The same applies to the anorexia, vomiting, constipation and failure to thrive. The above symptoms are also a feature of the "benign" type of hypercalcemia described by Lightwood[11] and abate when the hypercalcemia subsides.

If the serum calcium remains elevated too long, permanent damage is done to many tissues. Systemically, this is manifested by the marked retardation of growth which is a feature of this condition and which would undoubtedly result in permanent dwarfing if the patients lived long enough.

The toxic effects of calcium are most severe in the central nervous system, the kidneys and the heart. The damage to the brain causes marked mental retardation progressing to mental deficiency. This was a feature of all our cases.

With the exception of our Case IV, all the cases of hypercalcemia showing osteosclerotic changes have suffered severe renal damage; indeed most of them die of renal insufficiency. Many of the features of the severe form of hypercalcemia are the result of these secondary changes in the kidneys. They cause the polyuria with thirst and sometimes dehydration which is frequently present, and also the hypertension and azotemia which most of these patients show. For the same reason their urine is of low specific gravity and usually contains albumin and pus. The unexplained pyrexias from which they are apt to suffer are probably of renal origin. Finally the irritable, unhappy temperaments of these children are probably a consequence of their renal injury. In this respect they differ markedly from the placid contented children with the "benign" form of the disease described by Lightwood.

In the heart, calcium is deposited and extensive damage may be done to the endocardium and myocardium. Several of the cases in the literature and 2 of ours had systolic murmurs which may have been due to calcification and damage to the endocardium in the neighborhood of the aortic valves. Furthermore, at least one of our cases showed disturbances in rhythm with electrocardiographic changes, suggesting the presence of myocardial damage as well.

In addition to these direct and indirect manifestations of hypercalcemia, certain other abnormalities seem to be seen frequently in these patients. They have no apparent relationship to each other or to the high calcium levels, which suggests that the syndrome may be a genetically determined, inborn abnormality involving, among other defects, an error of calcium metabolism.

Unfortunately, the blood cholesterol and serum proteins were not investigated in our patients. In the reported cases in which they were determined, the cholesterol level was always raised and abnormal globulins were frequently present as well. In view of the association of the condition with cretinism, the hypercholesterolemia may be of interest.

One of our patients and at least 3 of those described by others[6,7,9] had a characteristic facies which is shown in Figure 5 and has been described as elfin. They have prominent eyes, often mongoloid lids, hypertelorism, big mouths, small pointed heads, receding foreheads and chins and large low set ears, so that they look as if they were members of the same family or race.

One of our cases had unusually narrow sutures for its age and premature closure was observed by Fanconi *et al.*[6] and Creery[2] in their cases. Fanconi's patient had a true craniostenosis but the narrowing in our case may have been secondary to micrencephaly, so that the question of whether an abnormality of the sutures is another associated, unrelated anomaly is not at present clear.

One of our patients and the one described by Schlesinger were operated on for hypertrophic pyloric stenosis, but

again the severe vomiting observed in nearly all patients raises the question of whether the vomiting or the pyloric changes came first.

The relationship between hypercalcemia and hypothyroidism is not at present clear. So far as is known, the only other recorded case of raised serum calcium values in a cretin is that reported by Naylor.[15] Braid[1] described a cretin with dense bones and widespread soft tissue calcification but normal blood values. Robertson[19] and other workers found that hypothyroid individuals excreted calcium and phosphorus less readily than persons having normal thyroid glands and stored them in bone but found no instances of raised serum levels. Fanconi's observation that cretins are more sensitive to vitamin D than normal children is of great interest in this connection. Further investigation will be needed before it is clear whether the two conditions are simply coincidental or genetically linked or whether one is secondary to the other.

ROENTGEN FINDINGS

Roentgenograms show widespread osteosclerosis, evidence of defective bone formations and abnormal soft tissue calcifications.

Osteosclerosis involves all bones and is particularly apparent in the base and frontal regions of the skull, the vertebral bodies, the carpal bones and the epiphyses and the ends of the shafts of the long bones. It seems to affect mainly the spongiosa, for the bony cortex appears normal or sometimes slightly thinned. The increase in bone density may be amorphous, as in the base of the skull or due to thickening and coarsening of the individual trabeculae; it is not associated with disturbance of the trabecular pattern.

The osteosclerotic changes are not distributed evenly but occur in bands or zones which shade off gradually into bone of normal or even diminished density, as if the intensity of the disease had varied at different stages of growth. Because of the way new bone is laid down, these bands appear transverse in the shafts of the long bones and ring-like in the epiphyses, vertebral bodies and other round bones. As many as six such bands can be distinguished in the lower femoral shafts of Case I (Fig. 2). In Cases I and III a few of the intervening areas between the sclerotic bands in the long bones seem to be of less than normal density and to show thinning of their trabeculae. It is very hard to be sure whether true porosis is present, however, particularly in view of the muscular hypotonia which is invariably present and must be expected to result in some disuse atrophy.

Other bone changes are seen in addition to the osteosclerosis. They appear to be due to impaired bone formation. This is most evident at the ends of the long bones which are cupped and often ill-defined; identical appearances may be seen in rickets and osteopetrosis (Fig. 6 and 7). In other cases the epiphyses are recessed into the ends of the long bones as if these had been softened and the epiphyses pressed into them (Fig. 2). Other manifestations are undertubulation, observed in Cases I and II (Fig. 2 and 6), and retarded bone development which was a feature of all but one of our cases. Despite their increased roentgenographic density, the bones are probably softer than normal for they often become bowed by the hypotonic muscles. This is seen in the lower radial and ulnar shafts in Figure 3.

Ectopic soft tissue calcifications are most commonly seen in the renal parenchyma, as was the case in 3 of our patients and many of those in the literature. As Case I demonstrates, however, they may also be seen in blood vessels, the brain, intermuscular planes, bronchi and a variety of other structures.

DIFFERENTIAL DIAGNOSIS

Except for the hypotonia, the condition is indistinguishable clinically from renal acidosis, which does not, however, present the marked bone changes seen in hypercalcemia. While patients with renal acidosis

may show transient and slight rises in their serum calcium, their persistent alkaline urine and low serum alkali reserve should clarify the diagnosis.

As already mentioned, the hypotonia may at times be so marked as to simulate neuromuscular disorders such as poliomyelitis or muscular dystrophy.

The stunted growth, mental retardation and peculiar facies may make it very hard to distinguish these patients from cretins. Their hypercholesterolemia may add to the difficulty. Out of the total of 9 recorded cases 2 have, in fact, proved to have been suffering from hypothyroidism. While the other patients do not appear to have been suffering primarily from this condition, the relationship of hypercalcemia to thyroid function is not at present clear and it would certainly be of interest to investigate the thyroid function in any future cases.

Roentgenographically, it may be impossible to distinguish the bone changes from those of osteopetrosis (Albers-Schönberg disease). Both cause increased bone density, sometimes in rings and transverse bands, and both may be associated with undertubulation and cupping of the ends of the long bones. In our patients the increase in bone density has been less than in osteopetrosis and they have not shown the cortical involvement seen in that condition, but it is possible that if the sclerosis were severe enough the state of the cortex might become obscured. Raised serum calcium levels have been observed in this condition exceptionally. Although the distinction may be difficult roentgenographically, the clinical evidence should confirm the diagnosis. The picture of the severe infantile type of osteopetrosis with myelosclerotic anemia, cranial nerve involvement, hepatosplenomegaly and spontaneous fractures is very different from that of hypercalcemia with its severe mental retardation, renal and cardiac damage and soft tissue calcifications.

Other conditions which can cause widespread increases in bone density include leukemia, syphilis, lead, phosphorus and fluorine poisoning, hypervitaminosis A, Hodgkin's disease, physiologic osteosclerosis of the newborn, Levi's disease, and the osteitides of Putti and Sicord. Adequate clinical and roentgen examination should leave little room for real doubt, however, in these conditions.

The clinical and roentgen findings may simulate those of hypervitaminosis D. This is really not surprising as both are results of similar disturbances in calcium metabolism. Indeed, as will be shown later, it is doubtful whether there is any essential difference between the two conditions.

DISCUSSION

Idiopathic hypercalcemia is probably a rare and only recently observed disease of which many aspects remain to be clarified. At present, it is not known whether it differs in kind, or only in degree from the "idiopathic hypercalcemia with failure to thrive" described by Lightwood and his colleagues, which is also a rare disease. Since it was described in 1952, only 57 cases have been reported, nearly all in Great Britain. It seems to be a relatively benign condition, the hypercalcemia remitting after a few weeks or months with recovery of the patient and no evidence of lasting mental or physical damage. A few of the cases are reported to have shown linear densities at the growing ends of their long bones, but it is doubtful whether these were more pronounced than the changes which are liable to occur in any child who fails to thrive regardless of the cause. Apart from these, the "benign" cases did not show bone changes, nor did they show any of the associated abnormalities such as the peculiar facies found in children with the severe type of hypercalcemia described here.

On the other hand, we have already seen that many of the changes seen in our patients were due to the toxic effect of persistently high calcium levels on various organs. It may be that all the abnormalities associated with the severe type are caused in this way and that these patients only

differ from those with the benign type of hypercalcemia in that the condition fails to remit before permanent damage is done. Some support for this is provided by the case recently described by Fanconi[7] which seemed to be intermediate between the two types in that he had the peculiar facies associated with the severe form and minimal sclerotic changes in the long bones, but showed an apparently permanent remission of the hypercalcemia and restoration of the long bones to normal after treatment with cortisone. A third possibility, of course, is that all these patients may be suffering from the same basic anomaly of calcium metabolism, and that it occurs in isolated form in the benign type and in association with various other genetically linked anomalies in the severe type.

It is interesting to speculate as to the possible nature of the disturbance of calcium metabolism. Since severe renal damage is almost invariably present in patients with idiopathic hypercalcemia and osteosclerosis, the possibility of it being the basic disorder must be considered. Transient elevation of the serum calcium may be seen in infants with renal disease but alterations as large and persistent as those shown by our patients are not known to occur. Crawford *et al.*[4] have recently described osteosclerotic changes in adults with chronic renal disease, but these were relatively minor and in no way approached the striking findings in our series. Strong arguments against a renal basis for the disorder are provided by Case IV, which showed extensive bone changes but remarkably little evidence of renal impairment despite the heavy calcification, and by Case III in which the most marked changes are seen in bones formed in utero when excretion would be placental rather than renal.

Hyperparathyroidism is a cause of hypercalcemia and Selye has produced osteosclerosis in animals by prolonged administration of parathormone. If the high serum calcium levels were due to hyperparathyroidism, however, the serum phosphorus levels should be depressed rather than normal or even slightly raised, as it was in our cases. Furthermore, increased bone density due to hyperparathyroidism has never been described in humans; the opposite, of course, is the rule.

Bone changes which in many ways resemble those in our patients are seen in osteopetrosis (Albers-Schönberg disease). Pincus *et al.*[17] demonstrated abnormalities of calcium and phosphorus in a patient with this disease and considered it to be basically a parathyroid disorder. Several of the recorded cases of osteopetrosis are said to have had high calcium levels but, unfortunately, the data on most of them are incomplete so that it is impossible to be sure whether they were true examples of that disease or unrecognized cases of idiopathic hypercalcemia. At least 2 incontrovertible examples of osteopetrosis with hypercalcemia have been reported, however, by Flood[8] and by Péhu *et al.*,[16] the patient described by the latter having a parathyroid tumor as well. In spite of this, it seems unlikely that the patients described in this article were suffering from osteopetrosis. The lack of change in the cortical bone in all recorded cases of hypercalcemia and the very different fates of the two groups of patients provide good reasons for regarding the conditions as different entities at the present time. The sequence of events in our Case III and in those described by Fanconi[7] and others,[6] where some regression of the bone changes was observed, provides support for this, for, so far as is known, it has never been seen in osteopetrosis.

As already mentioned, the clinical and roentgenographic changes in these cases are identical to those produced by excessive doses of vitamin D. Although, by current standards, the intake was never excessive, the possibility of vitamin D poisoning cannot be altogether ruled out. It is of interest to note that some patients with hypercalcemia have been reported to have become worse after small doses of vitamin D or even after exposure to sunlight. There are grounds for believing that requirements of vitamin D vary greatly from one individual to another. Fanconi[7] has suggested

that patients with idiopathic hypercalcemia are at the opposite end of the scale to those with resistant rickets, who require very large amounts of vitamin D before they can form normal bone, and that they are poisoned by amounts of vitamin D which are harmless to most of us. If this is so, and our patients are so sensitive to vitamin D that they are injured by the presently accepted prophylactic dose of it, the disturbance in their calcium metabolism would be accounted for. Such a hypersensitivity, which could well be genetically determined, seems the most likely explanation in our present state of knowledge.

SUMMARY

Four cases of idiopathic hypercalcemia, one of which was also a cretin, are described. The clinical features may be attributed to the raised serum calcium level, to changes in organs damaged by prolonged hypercalcemia, and probably to associated abnormalities. The facies, the muscular weakness, anorexia, vomiting, constipation, and failure to thrive associated with mental retardation and deterioration may suggest the diagnosis. The roentgen features, which are discussed at length, may be characteristic and should not be confused with those of any other entity. Amorphous increase in density of the skull and epiphyses, transverse bands of increased density at the ends of the bones, faulty tubulation and deposit of calcium in the soft tissues, particularly in the kidneys, distinguish this condition from other metabolic diseases. The etiology is unknown but the most likely cause is considered to be hypersensitivity to vitamin D.

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COEXISTENCE OF PAGET'S DISEASE OF BONE AND MULTIPLE MYELOMA

CASE REPORTS OF TWO PATIENTS

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THE coexistence of Paget's disease of bone and multiple myeloma is rare. This is not surprising since neither disease is common and the association of the two in one patient still less common. Paget's disease of bone has been reported as occurring approximately once in 850 admissions to general hospitals.[11] Higher rates of 1 in 170 to 1 in 400 admissions were obtained from statistics of hospitals devoted to the treatment of bone or rheumatic diseases. Between 1949 and 1952, for 1,000,000 patients admitted to Veterans Administration Hospitals, a total of 1,900,000 general diagnoses was recorded. Of these, 1,136 patients (1:880) were diagnosed as having Paget's disease of bone and 900 patients (1:1,111) as having multiple myeloma. In only 2 cases did the two occur together. We have reviewed the records of discharged patients from ten city and voluntary hospitals* and found only 2 patients among 1,955,428 who were discharged with these combined diagnoses. A review of the literature reveals reports of 5 previous cases. Reich and Brodsky[10] reported a patient in 1945 and mentioned one Snapper had seen but had not published. Schmorl[12] presented a patient in 1912. Hanisch[5] described a patient in 1950 and Gross and Yelin[4] added one other to the literature in 1951. These patients, those found in the local hospitals mentioned above, and the 2 patients reported herein total 9 patients known to have had coexistent Paget's disease of bone and multiple myeloma.

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REPORT OF CASES

The current report covers 2 cases of multiple myeloma complicating Paget's disease of bone.

CASE 1

History. G.P., a sixty-three year old white male was admitted for treatment of a pathologic fracture of the upper right femur. About a week prior to admission, while walking, the patient had a sudden pain in the right thigh and was put to bed. There was no history of injury or other precipitating incidents. Although pain increased, the patient continued to work as a maintenance man and electrician. Two months previously Paget's disease of bone was diagnosed by his family physician. On day of admission there was evidence of a pathologic fracture with angulation, deformity, swelling and tenderness of the right thigh. The patient weighed 170 pounds. His blood pressure was 140/108 and pulse rate was 120.

Roentgen studies of the right femur and pelvis on admission revealed Paget's disease of bone. A large osteolytic area was present in the subtrochanteric region of the right femur through which a pathologic fracture had occurred. Roentgen rays of the skull showed no Paget's disease of bone, but there was a questionable area of radiolucency in the midportion of the parietal bone.

Laboratory Examination. Urinalysis and serology negative; no Bence-Jones protein; erythrocyte sedimentation rate 37 mm. per hour; white blood cell count 12,950; differential count, metamyelocyte—0, bands—2, segmented polymorphonuclears—66, lymphocytes—30, monocytes—0, eosinophils—0, basophils—2; platelets—adequate; red blood cell count 3.99

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million; Hb 12.8 gm.; hematocrit 38 per cent mean corpuscular volume 95 cubic micra; mean corpuscular hemoglobin concentration 33.7 per cent; serum calcium 12.3 mg. per cent; phosphorus 6.6 mg. per cent; alkaline phosphatase 14.9 Bodansky units; acid phosphatase 0.1 unit; total serum protein 6.3 gm. per cent with 4.4 gm. per cent albumin and 1.9 gm. per cent globulin.

Course in Hospital. On admission, it was apparent that the patient had Paget's disease with a destructive process in the right femur through which a pathologic fracture had occurred. He was placed in skeletal traction and the fracture reduced. Subsequently, the traction was removed and a double hip spica applied. A needle biopsy of the cystic area in the right femur showed only connective tissue. Using a trochar through an incision, an open biopsy was done; the diagnosis was plasma cell myeloma. A bone marrow aspiration also revealed 20 per cent plasma cells.

Two months after admission roentgen therapy was started. He received 5,600 r in air and

Fig. 1. Case 1. Roentgenogram of the skull demonstrates the presence of sharply delineated and beveled lesions, especially predominant in the frontal and parietal regions. These changes are usually observed in minimal Paget's disease of bone.

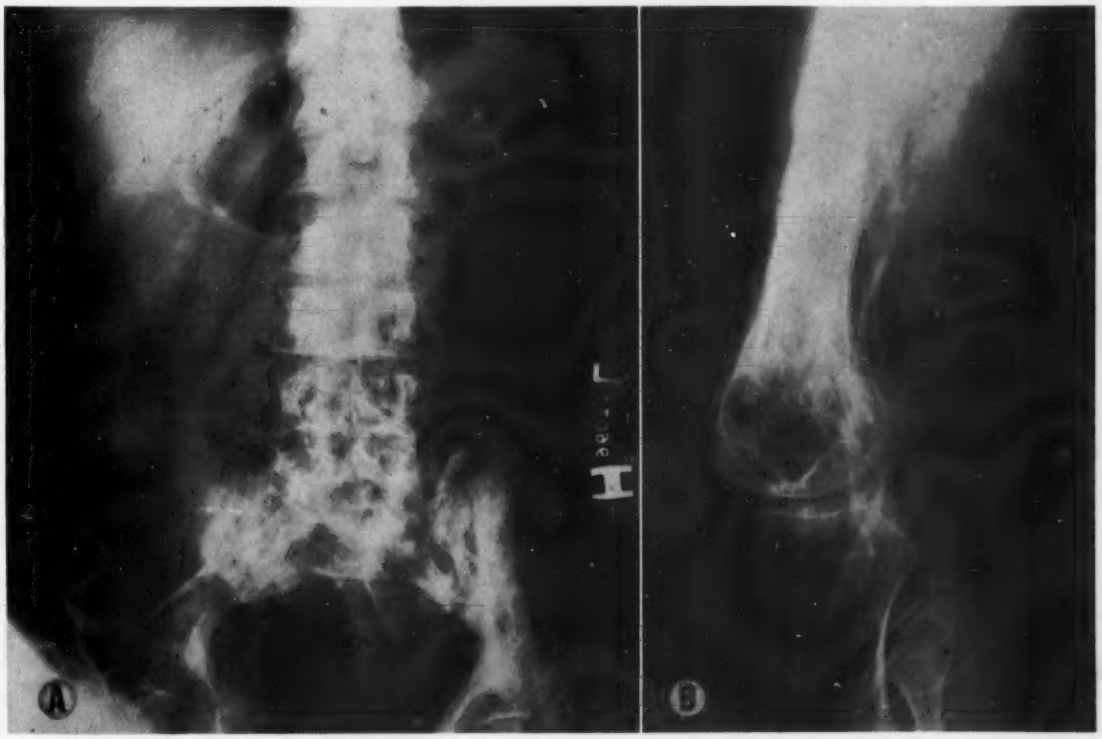

Fig. 2. Case 1. (*A*) Roentgenogram of the lumbar spine and pelvis shows changes characteristic of Paget's disease. (*B*) Roentgenogram of the right knee demonstrates Paget's disease involving the lower end of the femur. There is a considerable degree of osteoporosis present. Incidentally, there is noted calcification in the wall of the femoral artery.

FIG. 3. Case 1. Roentgenogram of the right femur demonstrates a fracture just below the lesser trochanter. There is very little evidence of callus formation. There are changes characteristic of Paget's disease and there are several areas of radiolucency in the medullary portion of the bone in the region of the fracture. There is also some calcification in the wall of the femoral aretery.

3,900 r to depth of the upper right thigh. This was followed by only slight relief. One month later treatment with urethane was initiated. The patient was made ambulatory, first with a walker and then with crutches. Urethane was discontinued because of the development of a low white blood cell count. No particular improvement was noted while he was receiving the drug. The patient had no complaints and was ambulating daily until approximately May 12, 1952, when he began to complain of very severe pain in the right knee and back. Roentgenograms of the right knee, femur and entire spine were taken. One view of the right lower femur suggested a lytic lesion in the distal femur in the condylar area. Roentgen studies of the spine showed a marked osteoporosis with "codfish vertebrae" with no evidence of lytic lesions or compression fractures. Urethane was started again and the white blood cell counts were maintained at 6,000 to 8,000, a satisfactory level. Patient's right leg was kept in a brace at all times to ease his pain. While there was intermittent relief, pain continued requiring large doses of morphine. On May 27, 1952, he was moved to a Stryker frame to facilitate nursing care. On June 7,

FIG. 4. Case 1. Characteristic changes of Paget's disease are noted, involving especially the humeral head on the right side and to a lesser extent the entire shaft.

1952, urethane was again discontinued because of nausea and vomiting. The white blood cell count on June 11, 1952, four days after stopping the urethane, was 3,550 with 87 segmented leukocytes, 2 bands, 3 lymphocytes, 6 monocytes, 2 eosinophils, and no basophils.

After June 15, 1952, the patient experienced severe pain in the right base of the skull near the ear and in the right thigh at the site of the pathologic fracture. Despite roentgen therapy to the right thigh, pain continued severe and increasing in intensity, requiring more frequent and larger doses of narcotics. The pain in the area of involvement of the right skull diminished considerably following roentgen therapy (total 2,000 r in air, using an 8×10 cm. portal), and was more annoying than severe. Because of the frequent use of large doses of narcotics, it was felt that pain-relieving neurosurgical procedure would be necessary. Accordingly, the patient was presented to the neurosurgeons, who advised a cordotomy. On August 25, 1952, the lamina of T-1, and T-2 were removed and a 5 mm. incision was made which severed all fibers in the left quadrant of the cord anterolaterally. Following cordotomy, the pain was relieved except for that in the head and neck regions. Patient's course continued to deteriorate. He expired on November 16, 1952.

Fig. 5. Case 1. Roentgenogram of the knee dated May 15, 1952 demonstrates changes in architecture characteristic of Paget's disease.

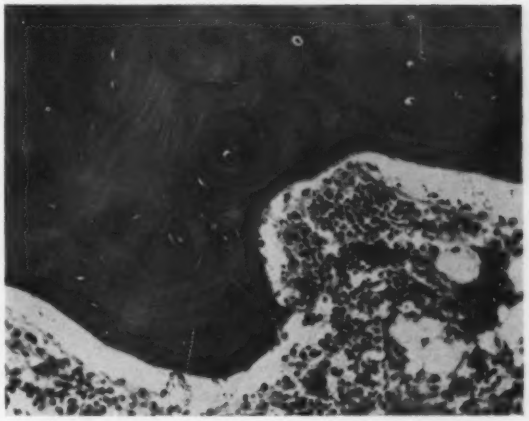

Fig. 6. Case 1. Microscopic section of right femur demonstrates coexistent Paget's disease of bone and multiple myeloma.

Pertinent Autopsy Findings. There was a 3.5 cm. soft brown cystic subcutaneous semiliquid pink-gray homogeneous mass in the right parietal region. Scattered punched out circular areas of the skull were noted similar to the tumor described above. There was partial destruction of bone. The skull elsewhere was irregularly thickened. The tumors were adherent and appeared to infiltrate the underlying dura. Tumors, likewise, were noted about the spinal dura, particularly in the upper thoracic and lower cervical regions. The external surface of the dura was the site of numerous flat plaques of tumor tissue. The largest of these was present in the frontoparietal region, in the midline overlying the superior sagittal sinus, measuring 3 to 4 cm. in diameter and protruding approximately 0.6 to 0.7 cm. It was solid, fleshy, somewhat lobulated, light yellow and exhibiting recent hemorrhages. The brain showed compression secondary to the plaques of tumor tissue described above.

Another tumor mass had evidently invaded and destroyed a lymph node adjacent to the superior vena cava medial to the hilus of the right lung. Both lungs showed consolidation. Scattered nodules, measuring up to 1 cm. in diameter, were present in both lobes.

The right femur was fractured in the region

of the acetabulum. The right lower extremity was 15 cm. shorter than the left. Examination at the site of the pathologic fracture revealed absence of most of the neck and all of the head of the femur. These had been replaced by scattered bone spicules, tumor, hemorrhagic and fibrous tissue. The shaft of the proximal end of the femur was markedly thickened and dense. Gray-white tumor nodules were present in the costal cartilage of the sixth right and fourth left ribs, in the head of the right humerus and in the medullary space of the sternum.

Microscopic Examination. Sections of the right lung revealed widespread severe bronchopneumonia. One of the nodules described grossly was a poorly circumscribed area infiltrated with plasma cells. These were characterized by round vesiculated nuclei with the chromatin arranged in irregular small clumps about the periphery of the nucleus. The cytoplasm was scanty, pale pink or blue, and the nucleus eccentrically located.

In the lymph node adjacent to the superior vena cava there was widespread replacement by large sheets of plasma cells resembling those described above. The superior vena cava was negative. There was a mass of plasma cells and delicate connective tissue strands in the lumen of a small vein, the wall of which was infiltrated with plasma cells.

Sections from various parts of the right femur revealed areas of plasma cells near the proximal end. These were associated with large sheets of fibrosis, thick irregular scalloped bony spicules and trabeculae between which there was loose vascular fibrous connective tissue. There were large areas of old hemorrhage and scattered small strands of osteoid and partly calcified fragments of tissue. A section from the region of the joint capsule revealed collections of plasma cells, inflammatory cells and thickened fibrous tags of synovial villi partly surrounded by a thick fibrous area. In the latter there were fragments of partly necrotic bone, some of which were associated with large foreign body giant cells. Section of the distal end of the femur revealed a large collection of plasma cells in which there were a few spicules of bone.

Sections of a number of bones (sacral and thoracic vertebrae, sernum, humerus, ribs) showed association of irregularly thickened trabeculae with infiltration of sheets of plasma cells in varying degrees.

The tumor of the scalp over the right parietal region was composed of large areas of plasma cells which infiltrated the connective tissue septa and striated muscle. The tumors of the dura were similar, consisting of large sheets of plasma cells infiltrating both sides of the dura. Sections of the skull from a thickened area revealed enlarged trabeculae with irregular cement lines. The marrow spaces were infiltrated with scattered plasma cells. Sections through an area of myeloma revealed replacement of many of the trabeculae with sheets of plasma cells.

CASE II

History. A.P. was a fifty-six year old white female nurse who entered the hospital on May 16, 1950, with the chief complaint of severe pain in the lumbar region and difficulty in walking for a period of one month. The patient stated that her illness began two years earlier when she had a polyp removed from the vagina and an anemia was found. Medication failed to improve her anemia. She was hospitalized for further study. While in the hospital, she complained of pain and swelling over one of the ribs. This rib was removed and the pathologic diagnosis was multiple myeloma.

On admission, her weight was 115 pounds, height 5 feet 7 inches, temperature 98.6° F. pulse rate 94, blood pressure 150/85. She was fairly well developed but quite poorly nourished and appeared chronically ill. She was mentally clear. Examination of the back revealed definite tenderness over the entire lumbar area and both buttocks as well as hip joints. Neurologic examination disclosed that the left leg could not be moved; there was a flaccid paralysis. Babinski's reflex was not present. There was a loss of pin-prick sensation and diminished temperature sensations below the left knee. There was also loss of vibratory sense below the left knee. The right knee and leg were markedly weak, but there was no change in perception to pinprick or temperature. Reflexes were present and active on the right side. Reflexes in the upper extremities were present and physiologic. Cranial nerves were intact.

Laboratory Examination. Hb 7.5 gm.; red blood cell count 2,870,000; white blood cell count 3,550 with a differential of neutrophils—76, lymphocytes—12, monocytes—9, eosinophils—3; platelets 289,870; nonprotein nitrogen 44 mg. per cent; blood urea nitrogen 36 mg. per cent; serology negative; total protein 10.9 gm.

per cent with albumin 3.1 gm. per cent and globulin 7.8 gm. per cent; calcium 9.7 mg. per cent and phosphorus 3.8 mg. per cent. Urine examinations were negative for Bence-Jones protein during the first two weeks but showed 2–3 white cells per high power field. Fishberg concentration after four hours showed a concentration of 1.026. Erythrocyte sedimentation rate was 27 mm. per hr. Phenolsulfonphthalein was 10 per cent. Repeat blood urea nitrogen was 16 mg. per cent, creatinine 1.2 mg. per cent. Subsequent urinalysis during the month of June showed many white cells per high power field. Serum calcium was 12.8 mg. per cent, phosphorus 4.7 mg. per cent, and alkaline phosphatase 2.3 Bodansky units. Approximately one and a half months later her red blood cell count was 1,870,000; white blood cell count 2,350, with a differential of neutrophils—62, lymphocytes—38; Hb 5.5 gm. Following two blood transfusions, patient's hemoglobin was 8.5 gm.; red blood cell count 2,270,000; white blood cell count 4,150, with a differential of neutrophils—86, lymphocytes—14; cephalin flocculation negative; thymol turbidity 1.3 units; alkaline phosphatase 4.1 Bodansky units. Two months after admission Bence-Jones protein in urine was positive and two subsequent specimens confirmed the positive findings. At that time hemoglobin was 4.5 gm.; red blood cell count 1,580,000; white blood cell count 2,300, with a differential of neutrophils—62, lymphocytes—35, monocytes—3.

Fig. 7. Case 11. Roentgenogram of the lumbar spine and pelvis shows extensive Paget's disease involving the left half of the pelvis and the proximal end of the left femur. Compression of the twelfth dorsal vertebra is noted. In addition, there is some partial compression of the second lumbar vertebra.

Fig. 8. Case 11. Roentgenogram of the skull demonstrates several destructive areas. There is one larger destructive area involving the frontal bone approximately in the midline. There are several spotty areas in the parietal bones. The roentgen appearance is entirely compatible with a multiple myeloma.

Roentgenograms of the skull revealed several destructive areas typical of multiple myeloma. Chest roentgenogram did not show any destructive areas in the ribs or in the shoulder girdle. Roentgenogram of the spine demonstrated destruction of the twelfth dorsal vertebra, and also of the eleventh dorsal vertebra. The destruction appeared to be neoplastic. There was a partial compression fracture of the twelfth dorsal vertebra. The roentgenogram was thought to be compatible with multiple myeloma. Roentgenographic studies of the lumbar spine and pelvis revealed extensive Paget's disease also involving the left half of the pelvis and the proximal end of the left femur. Re-examination of the lumbar spine three weeks after

FIG. 9. Case 11. Roentgenogram shows appreciable destruction of the eleventh and twelfth dorsal vertebrae which appears to be neoplastic in character. There is partial compression of the twelfth dorsal vertebra.

admission showed further compression of the twelfth dorsal vertebra; in addition there was some partial compression of the second lumbar vertebra. No change in the Paget's disease was noted. Bone marrow aspiration was examined and described as characteristic of multiple myeloma. A myelophthistic marrow with suppression of the erythroid and myeloid elements was noted.

Neurologic consultation disclosed cord compression at T-12 and L-1 segment with evidence of T-11, T-12, and L-2 vertebral destruction.

Course in Hospital. On admission, the patient complained of pain in her back, ribs, and hips for which she was given narcotics. Over the four-month period that she was in the hospital, the patient ran a downhill course. The narcotics controlled her pain poorly at best. She did not eat well and was quite depressed. On June 1, 1950, the patient was started on a course of stilbamidine of which she received approximately 20 doses with little or no improvement noted. On June 6, 1950, another course of elixir of urethane was started and subsequently she was given two blood transfusions since her hemoglobin was only 5.5 gm. and her red blood cell count was 1,870,000. After receiving this blood, the patient's hemoglobin was 8.5 and the red blood cell count rose to 2,270,000. Symptomatically the patient was somewhat improved, and her complaints of pain seemed a little less frequent. During July, the patient developed herpes zoster over the skin of her abdomen which gradually cleared spontaneously within four weeks. After a month, the elixir of urethane was discontinued and the patient again complained of pain which was only moderately abated by further urethane and roentgen therapy. The first week in August, the patient noticed small ulcerative lesions in her mouth. At that time she also ran a daily temperature elevation of 101° to 102° F. Over the last two-week period, the patient's downhill course was somewhat rapid and her pain was only moderately well controlled with dilaudid hydrochloride given every four hours. The patient became semicomatose and she died on September 4, 1950.

Pertinent Autopsy Findings. Upon removal of the calvarium, there was noted a punched-out ragged area measuring 1.5×0.5 cm. in the middle portion and in the midline of the frontal bone. The outer table was not perforated. The erosion was due to a soft red-purple tumor mass measuring 2.5 cm. in diameter which was entirely extradural. The spinal cord was exposed at the level of the tenth dorsal to the second lumbar vertebra. There was invasion of the lateral posterior surfaces of the vertebrae by a soft yellow-purple tumor. The muscles of the perispinal group were displaced laterally by this mass and appeared to be invaded by the tumor to some extent. Compression fractures of the eleventh and twelfth dorsal vertebrae were noted, and the underlying cord in this area was quite macerated, soft, gray-white and presented loss of normal architecture.

Microscopic Examination. Sections of the spleen revealed proliferation of reticuloendothelial cells and rare plasma cells. Sections of bone showed numerous myeloma cells. In sections of rib there was partial replacement of marrow by collagen fibers and multiple clusters of myeloma cells. A vertebral body showed a relatively normal cellular distribution of marrow with a few scattered clusters of myeloma cells. Another section of bone showed what was

considered to be evidence of fracture or collapse, with regeneration of bone. There were two smears of bone marrow, probably from post-mortem examination, in which there were many myeloma cells and a large number of myelocytes. The spinal cord showed multiple large zones of demyelinization. This was due to the effect of pressure on the spinal cord.

SUMMARY OF THE 2 CASES

Case I. G.P., a sixty-four year old male, had anemia, elevated erythrocyte sedimentation rate, a moderate tendency towards elevation of serum calcium, an elevated alkaline phosphatase, absence of hyperglobulinemia and Bence-Jones proteinuria, mild nitrogen retention, and normal urinalysis. Clinically, the patient presented himself because of pain in the right upper thigh at onset, followed by a pathologic fracture of the right femur one year later. Roentgen studies of bone revealed the presence of Paget's disease of bone and multiple myeloma, both corroborated at autopsy. He was treated with roentgen therapy and urethane.

Case II. A.P., a fifty-six year old female, had anemia, an elevated erythrocyte sedimentation rate, elevation of the blood calcium, normal alkaline phosphatase, hyperglobulinemia, Bence-Jones proteinuria, nitrogen retention and large numbers of white blood cells in the urine. Her presenting symptom was pain in the lumbar region and inability to walk. Roentgenographic studies revealed destruction of the eleventh and twelfth dorsal vertebrae with partial compression fracture of the twelfth dorsal and second lumbar vertebrae possibly due to multiple myeloma. There was also roentgen evidence of Paget's disease of the left pelvis and femur. She was treated with roentgen ray, stilbamidine and urethane.

DISCUSSION

There are certain similarities between Paget's disease of bone and multiple myeloma, but most findings clearly differentiate the two diseases. Both appear more commonly in patients of advanced years and affect males more often than females. Pathologic fractures of bones are recorded in both instances, although in Paget's disease fractures of the ribs are uncommon while they are found frequently in patients with multiple myeloma. In each, there may be shortening in height and paraplegia as a result of vertebral bone changes and destruction with compression. In both pathologic conditions, one may find associated cardiovascular disturbances. Bone pain is a common finding in both diseases. In Paget's disease calcium and phosphorus levels of the blood are usually normal, the alkaline phosphatase is elevated and the patient may have renal calculi. Anemia is not commonly found in patients with Paget's disease of bone and the bone marrow is rarely involved; likewise hyperglobulinemia and Bence-Jones proteinuria are not found in Paget's disease. In patients with multiple myeloma, the findings of Bence-Jones proteinuria, hyperproteinemia, hyperglobulinemia and abnormal electrophoretic patterns are of diagnostic significance. In approximately 50 per cent of patients with multiple myeloma, Bence-Jones proteinuria and hyperglobulinemia may be absent. Serum calcium is frequently elevated to very high levels, as high as 12 to 16 mg. per cent, while serum inorganic phosphorus and alkaline phosphatase are normal. There is evidence of renal failure which may be due to a combination in the tubules of Bence-Jones protein with ionized calcium to form casts and tubular destruction by blocking the lumen of the tubules.[9] Associated with such renal damage in multiple myeloma there is often found azotemia.[7] There is frequently an anemia which may be macrocytic in type and fail to respond to therapy. There is a tendency towards rouleaux formation which may play an important part in elevating the erythrocyte sedimentation rate. The findings of the multiple myeloma or atypical plasma cells in the circulating blood or in bone marrow aspirations or biopsy estab-

lish the diagnosis. In multiple myeloma there are abnormal electrophoretic patterns and the performance of this study may be of diagnostic value.[1]

Insofar as therapy is concerned, in both patients no therapy was directed toward the manifestations of Paget's disease since all attempts at reversing these pathologic changes have been unsuccessful.[11] For multiple myeloma both patients had trials with roentgen therapy and/or urethane;[8] in addition to these therapeutic agents, one was given stilbamidine.[13] Stilbamidine relieves bone pain; there is also a precipitation of ribose nucleic acid in the cytoplasm of myeloma cells which causes basophilic stippling without reduction of the total number of these cells.[6,13] ACTH,[14] radioactive phosphorus,[3] strontium,[3] Coley's toxin,[2] have also been used by others with similar subjective improvement.

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THE SIGNIFICANCE OF THINNING OF THE PARIETAL BONES*

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THERE has been considerable controversy over the significance and etiology of the occasional observation of thin parietal bones of the skull. The lesion was first observed by pathologists before the discovery of roentgen rays and was the subject of interest and speculation for such illustrious investigators as Virchow,[12] Maier,[7] Rokitansky,[9] Paget,[8] Chiari,[2] and Lobstein.[6] They, as well as Sandifort,[10] Walter,[13] Schmidt,[11] Kaufmann,[5] and others, considered the disease to be an atrophy of the parietal bones of the skull usually accompanying old age. Greig[4] and later Camp and Nash[1] considered it to be a congenital dysplasia of the diploe, which was not progressive. Camp and Nash stated that the only importance of the lesion was that it be recognized and not confused with other more important diseases of the skull. For this reason Greig, Camp and Nash, and Wilson[14] referred to it as parietal thinness rather than parietal thinning to emphasize the static nature of the abnormality. Recently, Epstein[3] has noted the concurrence of parietal thinness with postmenopausal and senile osteoporosis.

Roentgenologically the lesion appears as a depression of the outer contour of a portion of the parietal bone. The calvarium is thin in the area of involvement, primarily as a result of a decrease in thickness of the diploe, which may disappear completely. The outer table retains its normal thickness unless the lesion is severe, in which instance it may be thinned or absent. The depression of the outer surface of the skull is flat in most cases, but occasionally it is grooved. The depression is generally bilateral and almost symmetrical, although some cases of unilateral involvement have been reported.[15]

A case with thin parietal bones has been observed at the San Francisco Hospital from which it has been concluded that contrary to the opinions of Camp and Nash, Greig and Walter, and others, the condition usually described as thinning or thinness of the parietal bones may be a progressive disease.

REPORT OF A CASE

CASE 1. This patient was an eighty-five year old female whose main complaints were referable to her gastrointestinal tract and joints. Seventeen years previously she had had a partial gastric resection and postoperative irradiation for a reticulum cell sarcoma of the antrum of the stomach. She had subsequently suffered from nausea and epigastric distress which was attributed to gastritis. She also complained of pain in her knees and stiffness of her neck. She had headaches of one year's duration which were relieved by aspirin. Blood calcium, phosphorus, and alkaline phosphatase were normal.

Serial roentgenograms of the skull from April 2, 1937 to October 30, 1955 were available for study. The original films were obtained as a part of a routine skeletal survey for the detection of metastases. These early films showed a very slight symmetrical narrowing of the parietal bones beginning about 2 cm. from the midline and extending for about 7 cm. as measured on the Towne projection. The thinning was no greater than that seen on many apparently normal skulls. It was discernible in the lateral roentgenograms as an ill-defined area of diminished density in the anterior and mid parietal regions. The thickness of the bone was approximately 9 mm. in the midline. The diploe in the region of narrowing appeared slightly more porous than in other regions of the calvarium. The inner and outer tables were intact and of approximately equal thickness. The overlying scalp was normal. Hyperostosis of the inner table of the frontal bone was also

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present (Fig. 1). Subsequent roentgenograms of the skull were obtained on February 6, 1953. Over the period of sixteen years, there had occurred a marked narrowing of the parietal bones so that only a thin shell representing the intact inner table remained. This was 1 mm. in thickness and involved a segment of bone the length of which was not appreciably greater than on the original examination. The parietal bone for approximately 2 cm. on either side of the midline was not changed, but lateral to this there was a wedge-like decrease in thickness of bone from approximately 1 cm. to 1 mm. occurring over a segment of about 1.5 cm. in length. A similar transition occurred from thin to normal thickness of bone at the lateral margin of the lesion. The outer table was intact, smooth, and of normal width in the wedge-shaped area of decreasing thickness of bone, the entire loss of bone substance being due to a decrease in the amount of diploe. In the thinnest area the only portion of bone remaining was the inner table. At this time there was also a longitudinal sulcus in midline above the region of the sagittal suture, which appeared to have increased in depth since the original examination was made. On the lateral roentgenogram the thin bone was seen as an area of decreased density involving the parietal eminences and extending upward from the region of the superior temporal line. The lower margin was more or less in the form of a straight line and was almost parallel to the base of the skull. The hyperostosis of the inner table of the frontal bone had not changed (Fig. 2). The examination was repeated on October 30, 1955, at which time the skull appeared essentially the same.

The roentgenograms of the spine, pelvis and extremities, which had been obtained in the interval from 1937 to 1955, demonstrated a marked generalized demineralization which was presumed to be due to osteoporosis.

DISCUSSION

This case presents irrefutable proof that thinning of the parietal bones may be an acquired and progressive disease. On the initial examination the mid parietal bones were slightly thinner than other parts of the calvarium, but the difference was of such a slight degree that it would not have been detected unless reviewed after the full development of the lesion. Similar changes are frequently demonstrated by roentgenograms in otherwise normal skulls. During a period of sixteen years, there was a disappearance of diploe and a depression of the outer table which still retained its normal thickness, except in the region of maximum involvement where it disappeared completely. The migration of the outer table is similar to the change in position of the dorsum sellae as a result of an expanding lesion in the sella turcica and involves a resorption of bone along the outer cortical surface and a deposition of

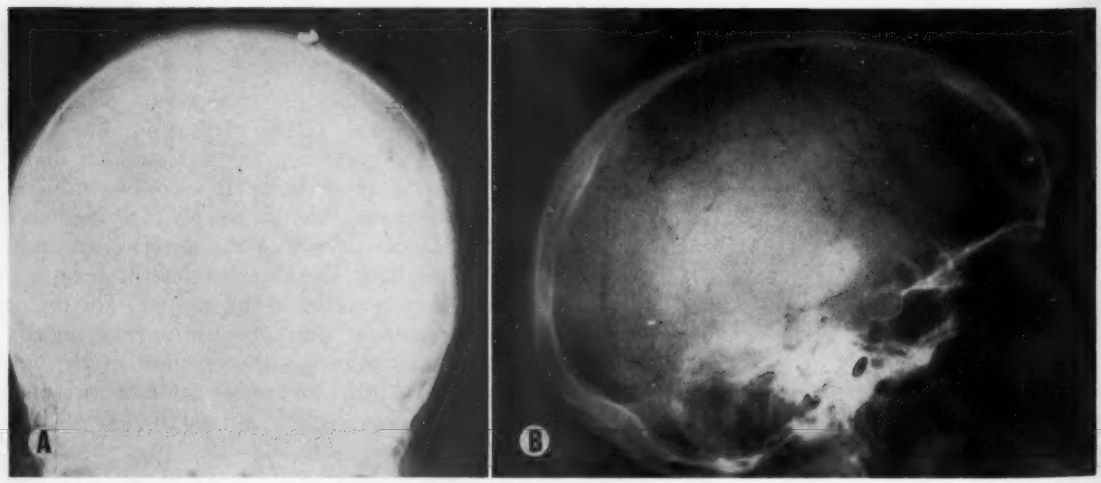

FIG. 1. Case 1. (*A* and *B*) Posteroanterior and lateral roentgenograms of the skull on April 2, 1937. There is very slight thinning of the parietal bone.

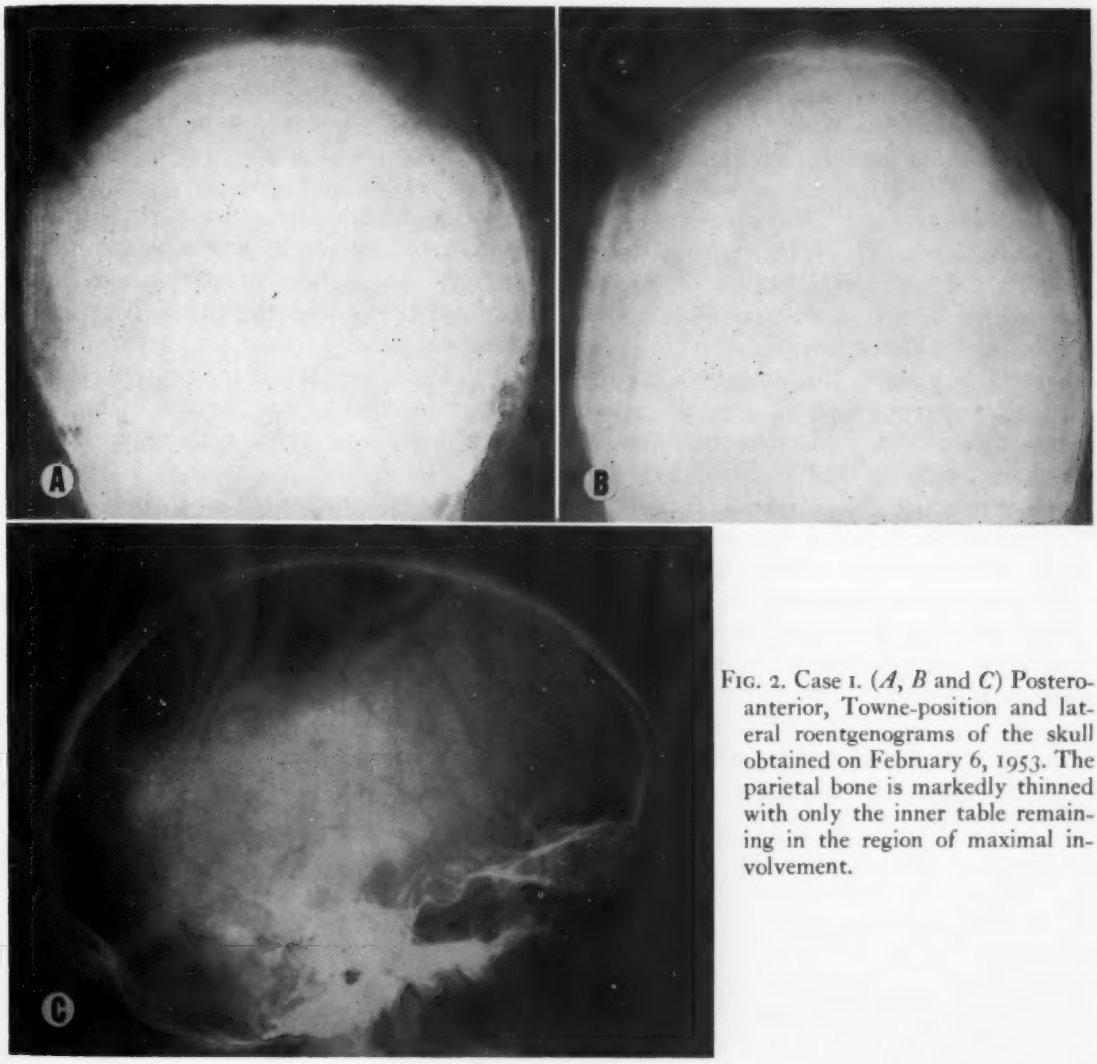

Fig. 2. Case 1. (*A*, *B* and *C*) Postero-anterior, Towne-position and lateral roentgenograms of the skull obtained on February 6, 1953. The parietal bone is markedly thinned with only the inner table remaining in the region of maximal involvement.

compact bone at an equal rate along the diploic surface.

There is evidence to suggest that the thinning of bone is associated with osteoporosis. The patient discussed was a female of sixty-nine years when the first roentgenograms were obtained and eighty-five years old when the maximum thinning was noted. She had severe generalized osteoporosis. Epstein reported a series of 26 patients with parietal thinning, 19 of whom were females. Roentgenograms of the spine of 19 of these patients revealed 16 with osteoporosis. Of 10 patients who had roentgenograms of the pelvis, 7 had evidence of osteoporosis; and of 10 patients who had roentgenograms of the extremities, 7 had evidence of osteoporosis. The patients not showing evidence of osteoporosis may well have had it but in an insufficient degree to be detected by the usual roentgen examination. The age of Epstein's patients ranged from fifty-four to eighty years, with 16 being between sixty-one and seventy years. Histopathologic studies of a case by Schmidt revealed a lack of osteoclasts with diminished bone formation rather than increased bone destruction; this suggested to him that the lesion was one of osteoporosis.

Camp and Nash presented a series of 119

cases with 80 of the patients being males and 39 females. Ten patients were thirty years of age or less; one was a four year old child and one was a nine week old infant, both children having slight but definite changes. The authors concluded that because some of the patients were too young to have senile or postmenopausal osteoporosis the lesion was due to diploic dysplasia and was not progressive. However, no history is given of these 10 younger patients. It is possible that some or all of them did have osteoporosis as a result of some other associated endocrine or metabolic disease. Some of the diseases associated with or producing osteoporosis are: gonadal deficiency, Cushing's syndrome, thyrotoxicosis, pituitary eosinophilic adenoma, parasellar lesions encroaching on the pituitary and producing pituitary insufficiency, primary pituitary insufficiency, impaired protein metabolism, malnutrition, vitamin C deficiency, lack of stress and strain associated with fracture or debilitating diseases, and osteogenesis imperfecta. In addition, there are other congenital dysplasias of bone which are frequently associated with osteoporosis.

Assuming that the typical thinning of parietal bones is an acquired lesion capable of progression and generally, if not always, associated with osteoporosis, it is interesting to speculate upon the cause of the specific localization of the lesion in the parietal bones and the absence of similar lesions in other parts of the calvarium. The area of involvement is the only part of the calvarium that is not the site of muscular attachment and subject to muscular tension. The frontal and occipital bones are the sites of attachment of their respective muscles. The temporal bone is the site of attachment of the temporalis muscle, the temporal fascia, and the masseter muscle. The temporal fascia attaches also to the superior temporal line and the temporalis muscle to the inferior temporal line; these are two prominent curved lines located just below the area involved by parietal thinning. The upper part of the parietal

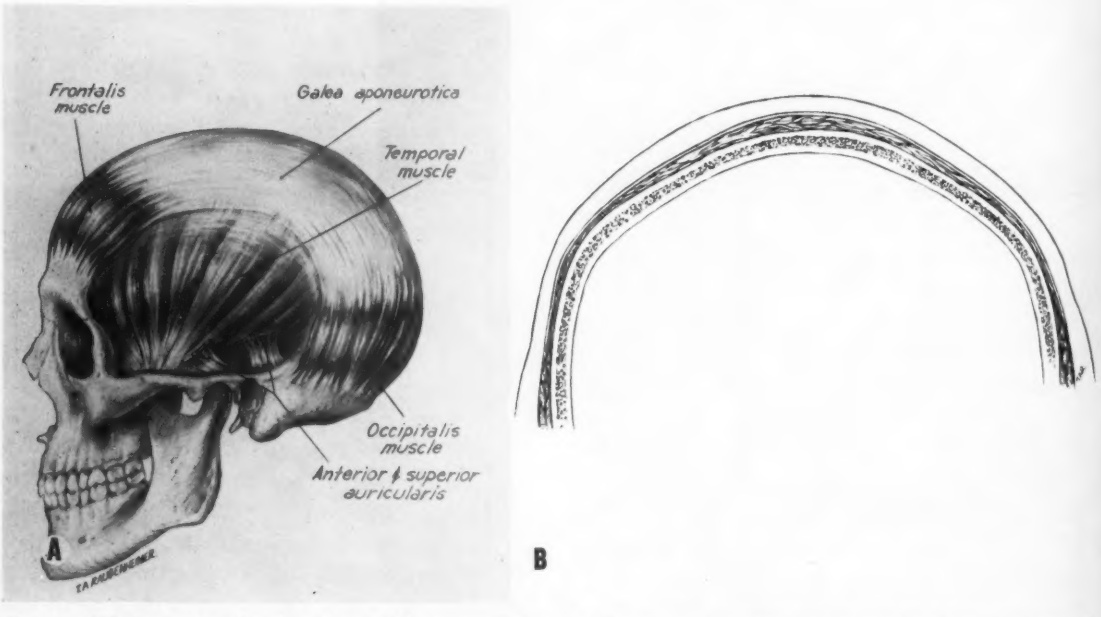

FIG. 3. (*A*) Drawing showing the galea aponeurotica and its muscular attachments. (*B*) Cross section of the parietal region of the head. The galea aponeurotica is in contact with the pericranium except at the lateral surfaces of the skull where it attaches to the temporal muscles.

bone is covered by the galea aponeurotica which is attached to the frontalis and occipitalis muscles, the external occipital protuberance, the anterior superior auricularis muscle, and the overlying skin. The galea aponeurotica has no connection to the parietal bone and actually moves a considerable distance over it as a result of contraction or relaxation of the adjacent musculature (Fig. 3).

It thus seems possible to explain the localized thinning of the parietal bone on the basis of decreased osteoblastic activity as a result of gonadal insufficiency, senility, or other causes of osteoporosis in a region where there is little stress and strain. The greatest pressure exerted by the galea aponeurotica is upon the superior parasagittal part of the parietal bone, and it is this region that retains its normal width in the presence of parietal thinning further laterally. This is suggested in Figure 4 which is a frontal projection of a pneumoventriculogram in which some gas escaped along the needle tract to the cleft beneath the galea aponeurotica. The gas has collected in the region of least resistance which corresponds precisely to the region in which parietal thinning occurs. The inner table of the skull continues to be subject to the pulsation and pressure of the intracranial contents which stimulates osteoblastic activity and maintains its normal thickness.

Although it is interesting to speculate upon the role of osteoporosis in the production of parietal thinning, it is obvious that there is no proof that such a relationship exists. Osteoporosis occurs to some extent in all elderly people, and yet the incidence of parietal thinning is low. Many patients with severe osteoporosis appear to have an increase in width of the diploe associated with thinning of the inner and outer tables. Also, the degree of parietal thinning is not proportional to the severity of osteoporosis. There are many other changes occurring in the body in senility, such as arteriosclerosis with associated nutritional impairment, which could be a much more important factor in the etiology of this lesion.

Fig. 4. Posteroanterior projection of the skull during taking of a ventriculogram. Gas has escaped beneath the galea on the left side and corresponds in position with the location in which parietal thinning is found.

Another case of parietal thinning occurring in a twenty-eight year old male with gonadal deficiency is reported because of the infrequent occurrence of this lesion in young persons.

REPORT OF A CASE

Case II. This patient was a twenty-eight year old male with a history of impaired-sexual and physical development, lack of libido, and obesity. He was referred to the University of California Hospital by Dr. Felix Kolb for evaluation of his skeletal maturation. Physical examination revealed a small thyroid cartilage, absence of body hair, small penis, prepuberal testicles, female escutcheon, and a flat prostate. Laboratory findings were: follicle stimulating hormone positive at 5 units and weakly positive at 80 units; 18 ketosteroids 6.8; compound F 9.9, and protein bound iodine 5.5. The clinical diagnosis was mild eunuchoidism, probably due to primary testicular atrophy. Roentgenograms of the hands and pelvis revealed the epiphyses to be fused, indicating a skeletal age of at least twenty-five years. There was no roentgen evidence of osteoporosis. Roentgenograms of the skull showed a definite narrowing of the parietal bones which was approximately symmetrical. The region of maximum thinning was a short segment of less than 1.5 cm. in length, producing a groove with sloping walls along its superior and inferior margins. The thinning was due entirely to a decrease in the thickness of

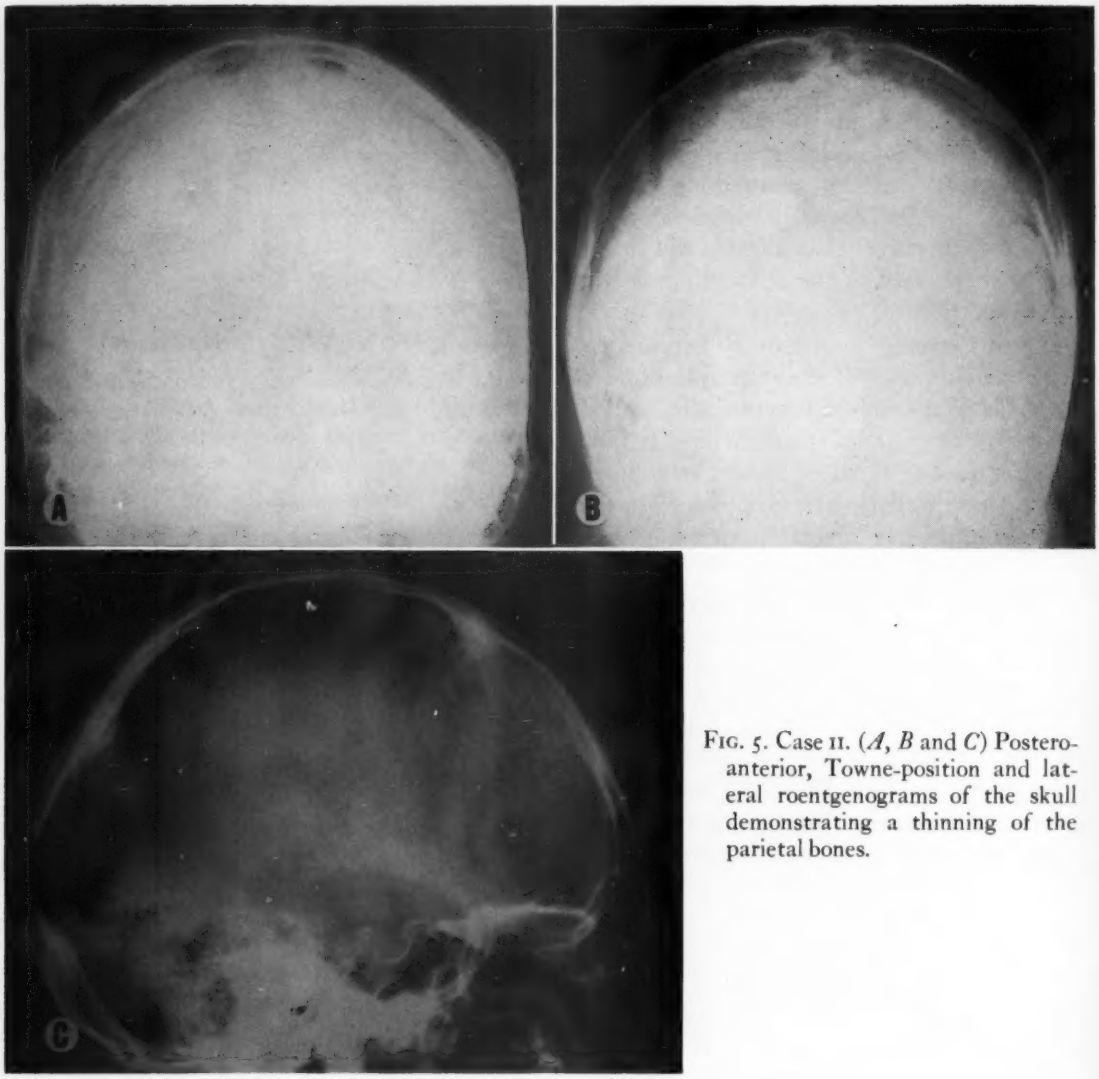

Fig. 5. Case II. (*A*, *B* and *C*) Postero-anterior, Towne-position and lateral roentgenograms of the skull demonstrating a thinning of the parietal bones.

the diploe. Superior to the parietal groove, the calvarium gradually widened until it reached the normal thickness in the midline and parasagittal areas. On the lateral roentgenogram an area of diminished density was demonstrated in the upper portion of the parietal bones with the lower margin above the superior temporal line and roughly parallel to the base of the skull. The diploe of the entire calvarium was porous (Fig. 5).

Our Case II was a relatively young male who had gonadal insufficiency. This could have resulted in a decrease in the amount of protein matrix of the bone and osteoporosis. No osteoporosis could be detected in the hands, wrists or pelvis. Epstein, too, could detect no demineralization of the skeleton in some of his cases, but it has been well established that roentgen evidence of osteoporosis is frequently a relatively late manifestation of the disease, and as much as 30 per cent of the calcium salts must have been removed before osteoporosis can be detected on a roentgenogram.

It is also possible that we are dealing with two distinct clinical entities: one, a progressive disease occurring in older individuals, and another, a congenital lesion which remains static throughout the life of the individual.

SUMMARY

Two cases of thinning of the parietal bones of the skull are presented, one in an eighty-five year old female with associated osteoporosis, and the other in a twenty-eight year old male with a diagnosis of eunuchoidism.

The first case is the only case reported to date in which progression of the lesion has been observed.

The possible role of osteoporosis and aging in the formation of thinning of the parietal bones is discussed.

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ADDENDUM

Since this paper was written, we have seen another patient with gonadal insufficiency and parietal thinning. This patient was a forty-four year old white male, sexually underdeveloped and having no facial and body hair except for scant pubic and axillary hair. On physical examination he had a small testis in the left scrotum and an undescended right testis. A testicular biopsy was performed revealing atrophic tubules, arrested maturation, and interstitial fibrosis. Roentgenograms of the skull showed bilateral grooved thinning of the parietal bones. There was no roentgen evidence of osteoporosis in the skull.

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OCHRONOSIS

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OCHRONOSIS was the name given by Virchow in 1866 to a disease in which he found severe generalized arthritis, discoloration of cartilages within the body, pigmentation of the eyes, the skin over the bony prominences and the intima of the large blood vessels by deposition of ocher colored granules. While almost all the cases are due to alkaptonuria, ochronosis may also occur following the external use of phenol and may be associated with the excretion of melanin in the urine. Alkaptonuria is a rare systemic disease characterized by the presence of alkaptone or homogentisic acid in the urine due to an inborn error in metabolism of tyrosine and phenylalamine. These substances are only broken down as far as homogentisic acid which accumulates in the blood and is excreted in the urine. Approximately 50 per cent of alkaptonurics develop ochronosis.

HISTORICAL REVIEW

Our knowledge of this disorder dates back to 1584 when alkaptonuria was first reported by Scribonius with subsequent cases by Schenk in 1609, Lusilanius in 1649, and Marcet in 1823. The first detailed report, however, was by Boedeker in 1858, who found, upon examining the urine of a patient with glycosuria, a second reducing substance which was not a sugar. He called the substance alkaptone because of its strong affinity for alkalis. The name of uroleucic acid was used by Kirk in 1886 and of glycosuric acid by Marshall in 1887, but apparently the substances described by these investigators were impure forms of what was isolated by Walkow and Bauman in 1891, and subsequently named homogentisic acid, a homologue of gentisic acid. Walkow and Bauman further demonstrated that the characteristic properties of alkaptonuric urine are due to the presence of the homogentisic acid. In 1866 Virchow described the pathologic features of a new disease which he named ochronosis because of the widespread deposition of the ocher colored granules. A relationship between ochronosis and alkaptonuria was suggested by Albrecht and Zdareck in 1902. Ochronosis caused by the application of phenol to a leg ulcer was reported by Pick in 1904. The roentgen findings were described by Soderbergh in 1915.

Ochronosis is quite rare. A well documented article was published by Pomeranz, Friedman, and Tunick[10] in 1941, in which the authors stated that only about 100 cases had been reported to that time, and of that number 30 were in the United States. Zeiter, in discussing the paper of Pomeranz, *et al.*, told of an additional case seen at the Cleveland Clinic in a fifteen year old girl with severe arthritis primarily of the small joints of the hands and feet. Smith[13] in 1942 stated that 82 cases of ochronosis were recorded in the literature including his 4 new cases reported primarily from the ophthalmologic viewpoint. Since Smith's paper Abbott[1] described 2 cases in 1942, Young[14] one case in 1944, Hertzberg[8] one case in 1945, Coodley and Greco[2] one in 1950, Eisenberg[5] one in 1950, Milch and Milch[9] 2 cases in 1951, and Sacks[11] one case from South Africa in 1951. Galdston, Steele, and Dobriner[6] reported on 3 cases and stated that approximately 200 cases had been described up to 1952. Cope and Kassander,[3] also writing in 1952, described a favorable response to cortisone in a patient without homogentisic acid in the urine and with no calcification in the intervertebral disks. One additional case is reported herewith.

CLINICAL AND PATHOLOGIC FEATURES

Ochronosis appears at about an average age of fifty years and the sexes are approximately equally afflicted. The disease lasts

throughout the life of the patient. There is a definite hereditary tendency, and the incidence of alkaptonuria has been shown by Bateson to be on the basis of mendelian inheritance of recessive characteristics. According to Sacks, in 42 per cent of reported cases there has been a history of consanguineous marriages, particularly of first cousins.

Alkaptonuria may be suspected in infancy on the basis of black discoloration of the diapers or clothing from the alkaptonuric urine, or it may go unrecognized until later in adult life when it may be found to be the cause of severe arthritis or when ochronosis appears. When first voided the urine may be normal in color, but it passes through stages of slate color, brown and finally black on standing. Alkalinizing or heating the urine accelerates the color changes. Since Benedict's or Fehling's solutions are reduced by the urine, a mistaken diagnosis of diabetes mellitus is sometimes entertained, but the fermentation tests are negative since the causative agent is an aromatic acid rather than a sugar. The presence of homogentisic acid can be demonstrated in the urine by the formation of a yellow precipitate with Millon's reagent and by the transitory bluish green color produced by the addition of a drop of ferric chloride to the urine. The urine will reduce silver lactate and silver nitrate solutions. The homogentisic acid is excreted from the blood primarily by the kidneys, but lesser amounts are excreted by the sweat glands so that discoloration of the clothing from perspiration may occur.

Most alkaptonuric patients, as they grow older, acquire the findings of ochronosis with extensive arthritis and the deposition of pigment in the ears, sclerae and skin. Ochronosis is not solely due to alkaptonuria, however, and may be associated with the external use of phenol or with the excretion of melanin in the urine.

Examination of a patient with ochronosis reveals discoloration of the skin of the ears, sclerae, head, neck and torso. Where arthritis is present, there is swelling and deformity of involved large and small joints. The back is usually rigid and kyphotic. Pomeranz, *et al.*[18] have described the posture as reminiscent of Paget's disease with the head thrust forward, the neck muscles appearing unduly prominent and the chest large and somewhat emphysematous. The arms are held limply at the sides. The patient walks slowly and with difficulty and the lower extremities may be moved in toto.

The ears frequently are involved early with a grayish blue discoloration and there is a feeling of rigidity possibly with nodularity on palpation. There is a fairly high incidence of cardiovascular disease associated with ochronosis, undoubtedly related to the metabolic anomaly.

Hertzberg's description of the pathology of ochronotic joints is worth repeating:

"The ochronotic pigment is deposited in the articular cartilage, especially in old cartilage with poor metabolism. This becomes black, loses elasticity, becomes brittle and shows little resistance to mechanical strain. The cartilage cracks easily and small black fragments may be wrenched off into the joint where they soon become attached to synovial membrane, gradually becoming firmly affixed to this and embedded. Mechanical strain leads to changes in articular surfaces with sclerosis, and in other parts with formation of cysts and small infractions. The subchondral bone marrow is irritated, proliferates and grows into the diseased cartilage. Marginal exostoses are formed. Pigmented cartilage is reported to be able to become forced up into the marrow cavity, being surrounded there by growing granulation tissue (Kleinschmitt 1922). The cartilage may disappear, leading to bony ankylosis. Several investigators have also reported the presence of osteoporosis in this disease. The pigment is deposited much less in the osseous system than in the cartilage. A lacunar resorption occurs and these patients are frequently subject to fractures as a result

of minor injuries. The morbid process greatly resembles those observed in ordinary deforming osteoarthrosis."

REPORT OF A CASE

T. K., a sixty-three year old white male, entered Maumee Valley Hospital on May 2, 1946, with the chief complaint of stiffness of all joints and muscles, which dated back to his first admission in 1931, and had gradually become worse since that time. He now complained of a deep burning pain which usually began in the toes and soles of the feet and radiated to the small of his back. He had gradually become stiff all over and could scarcely move. The pains had no relation to position and often prevented him from sleeping.

Family History. The father had died at the age of sixty-five and the mother at fifty-five of unknown causes. One brother died of influenza at the age of sixty-five. One brother died of an unknown chronic disease at an unknown age. One sister had died after a four month illness of an unknown cause.

Past History. The patient had pneumonia and malaria in 1913. He entered Maumee Valley Hospital on October 30, 1931, complaining of pain and swelling in the knees and ankles and occasional soreness in the back. He stated that in 1927 he had contracted gonorrhea and a chancre. About three months later he developed a swollen painful right knee; six months later his left knee swelled. This was followed by swelling of the ankles and pain in the back. He had been unable to work since 1929. The initial urethritis had continued with exacerbations and remissions until about four months prior to admission. No other complaints or illnesses were recorded.

Physical examination at the admission revealed a well developed, well nourished white male lying quietly in bed and not acutely ill. The ears were very hard and calcified. No granules were palpated. The heart was enlarged to the left with distant sounds. A systolic murmur was heard over the pericardium, loudest over the aortic area. There was a suggestion of a diastolic murmur. The blood pressure was 140/92 mm. of mercury. The temperature was normal. Both knees were enlarged but not inflamed. The examiner felt that a bony overgrowth was present. The knees could be extended to 180 degrees while flexion was limited to approximately 120 degrees. The prostate gland was markedly enlarged and moderately tender. The seminal vesicles were also enlarged.

Urine examination revealed an acid urine with a specific gravity of 1.015. No albumin was present. Sugar was noted on 2 of 13 examinations. The peripheral blood showed 4,490,000 red blood cells, 85 per cent hemoglobin, 5,500 white blood cells, and a normal differential. Kolmer and Kline tests for syphilis were negative. Blood urea was 18 mg. per cent, creatinine 1.3 mg. per cent, blood calcium 13.1 mg. per cent, blood sugar 93 mg. per cent, nonprotein nitrogen 40.8 mg. per cent and total protein 6.8 gm. per cent. The sedimentation rate was 6 mm. in 70 minutes and 12 mm. in 3 hours 10 minutes. A complement fixation test for gonorrhea was negative.

Roentgenograms taken at that time (1931) were destroyed before this study was undertaken. A report on them, however, is available. The ankles were described as showing spur formation and sharpening of the joint margins due to arthritis. The knee joints showed marked bony proliferation. There was sharpening of the joint margins of both hip joints. The shoulders were similarly affected. The vertebrae were reported as showing marked spur formation with narrowing of the joint spaces throughout. The spine was partially ankylosed, especially between the fourth and fifth lumbar vertebrae. The impression was that of extensive arthritis.

The patient had a bilateral vasotomy performed and was discharged on January 13, 1932, with a final diagnosis of gonorrheal arthritis, prostatitis, and seminal vesiculitis.

The physical examination on the second admission in 1946 revealed a fairly well nourished white male showing moderately marked arthritic deformities of the spine, hips, knees and wrists. The pupils were round and equal and reacted to light and accommodation. The sclerae had a bluish tint and there were dark brown areas of pigment in spiral shaped forms on both sides of the pupils starting about 1 mm. from the limbus. The cartilaginous portions of both ears were completely calcified being hard, unyielding and dark in color. The hearing was unimpaired. The teeth were poor and the gums were boggy and injected and bled on pressure. The neck showed limitation of motion both anteroposteriorly and laterally. The chest showed very little movement with respiration. A bony prominence 2 cm. in diameter was present at the sternoclavicular junction on the

right. The percussion note was resonant and no rales were present. Examination of the heart showed the point of maximum impulse just lateral to the midclavicular line. A short systolic thrill was felt at the third left interspace. The blood pressure was recorded as 180/90 mm. mercury by one examiner and as 110/70 by another. The pulse was 84 per minute and regular. A loud high pitched systolic murmur was heard best at the third left anterior interspace. The abdomen was slightly obese with no masses or viscera palpable. The genitalia were normal. With the exception of the elbows, the extremities showed limitation of flexion and extension, particularly of the hips and knees. The peroneal and tibial tendons showed calcification extending from their insertion proximally into the muscle bellies. The impression was that of ochronosis due to alkaptonuria.

The voided urine was dark and turned black on standing in sunlight. It reduced Fehling's solution in a peculiar way, turning dark after reducing. The alkalinized urine turned photographic paper black in a few seconds. Dilute ferric acid produced a transient blue color when dropped into the urine. Fermentation of urine did not take place.

The urine examinations from April 24, 1946, to December 23, 1946 showed a pH varying from 4.5–7.5 and a specific gravity varying from 1.003 to 1.023. The albumin was 1 plus on one occasion and negative the rest of the time. There was a trace of sugar on two occasions and none on the other examinations. There were white cells in the urine varying from a few most of the time to 200 per low power field on one occasion. In three blood cell and differential counts the hemoglobin varied from 11.6 to 15.3 gm.; the red blood cells from 4.02 to 5.2 million; the white blood cells from 5,700 to 9,900; the polymorphonuclear leukocytes from 70 to 78 per cent; the lymphocytes from 12 to 33 per cent; the monocytes from 0 to 2; and the eosinophils and basophils from 0 to 1. The total serum protein was 9.2 gm. per cent with the albumin 6.92 and the globulin 2.28 gm. per cent. The sedimentation rate was 1.5 mm. in 20 minutes and 9 mm. in one hour. The blood sugar was 66 mg. per cent on one examination and 81 mg. per cent on another. The calcium was 9.4 mg. per cent. Homogentisic acid was present in the urine on many occasions. The uric acid was 3.1 mg. per cent. The Wassermann and Kahn tests for syphilis were negative. The acid phosphatase was 4.0 King Armstrong units and the alkaline phosphatase 9.5 King Armstrong units. A biopsy from a tendon on the medial posterior aspect of the right leg, four inches above the malleolus, showed pigment consistent with ochronosis.

The patient was placed on crude liver with no change in the output of homogentisic acid. He suffered from fairly marked ankle edema which was treated with mercurial diuretics. Small ulcers which healed in approximately three months developed over the medial aspect of the right leg following trauma. The patient's condition remained essentially unchanged during hospitalization and he was discharged on April 5, 1948.

ROENTGEN FINDINGS

The roentgen findings in ochronosis have been described in detail by Pomeranz, *et al.*[10] The spine, pelvis, shoulders, knee joints and ears are the areas which are characteristically involved although other joints may show very similar changes. These findings are well demonstrated in the roentgenograms of our patient.

In the spine (Fig. 1 and 2) there was

Fig. 1. Lateral roentgenogram of lumbar spine showing calcification of intervertebral disks.

Fig. 2. Lateral roentgenogram of dorsal spine. The intervertebral disks are calcified and moderate kyphosis is present.

Fig. 3. Roentgenogram of the pelvis taken on March 2, 1937, showing changes in right femur.

osteoporosis and an accentuation of the normal kyphosis of the dorsal spine. There was ankylosis of the articular facets and the vertebral bodies of the lumbar and dorsal vertebrae. The space between the vertebral bodies of the dorsal and lumbar vertebrae was narrowed and there was calcification of the intervertebral disks, most pronounced in the lumbar vertebrae where all the disks were involved, but also present in most of the dorsal intervertebral disks. This calcification of the intervertebral disks has been considered so typical a finding that Pomeranz, *et al.*[10] made the diagnosis in their first case from the roentgenograms, but Milch and Milch[9] feel that it is highly suggestive but not pathognomonic of ochronosis. They state that it does not occur in all alkaptonurics, and that multiple disk calcifications are present in arthritics without evidence of alkaptonuria. The associated ankylosis and lack of massive spurring could scarcely be on an arthritic basis in our opinion. There was considerable sclerosis and some irregularity of the lower portion of the body of the sixth and the superior portion of the seventh dorsal vertebra. The space between these vertebral bodies was not fused nor was the disk calcified. There was new bone formation of the anterior margins of the bodies of the last lumbar and first sacral vertebra.

Studies of the pelvic bones (Fig. 3, 4, 5 and 6) made on March 2, 1937, August 5,

Fig. 4. Roentgenogram of the pelvis taken on August 5, 1942, showing advanced osteoarthritic changes in both hip joints and fusion of the symphysis.

Fig. 5. Roentgenogram taken on May 1, 1946, showing advanced osteoarthritis of both hips.

1942 and May 1, 1946 showed definite progression of the disease. The film on March 2, 1937, showed the left hip joint essentially normal except for slight narrowing of the joint space. The superior portion of the head of the right femur was absent. The remaining portion of the femoral head was slightly increased in density and lay higher in the acetabulum than normal. There was slight flattening, irregularity and sclerosis of the superior portion of the right acetabulum. The sacroiliac joints were somewhat indistinct. The symphysis pubis was not fused. Irregular flocculent calcifications were present between the lesser trochanter on the left side and the ischial tuberosity,

Fig. 6. Roentgenogram taken on May 1, 1946, showing marked osteoarthritis of both hips, fusion of the sacroiliac joints and extensive calcification about the ischial tuberosities.

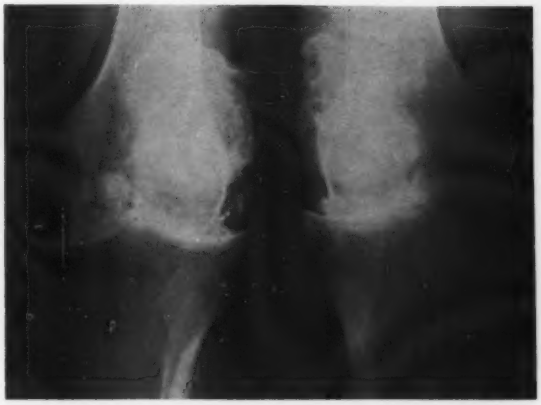

Fig. 7. Anteroposterior roentgenogram of both knees taken on August 5, 1942, showing marked osteoarthritic changes.

and similar, but less well developed,changes were present along the lateral margins of both greater trochanters and just inferior and lateral to the right ischial tuberosity.

By August 5, 1942 marked progression of the disease had occurred. Advanced osteoarthritic changes were present in both hip joints with almost complete obliteration of the joint spaces and marked sclerosis of the femoral heads and the acetabula. The deformity of the right femoral head and acetabulum was more pronounced than previously. The symphysis pubis was now fused. The sacroiliac joints were almost fused and there had been an increase in the flocculent calcifications inferior and lateral to each ischial tuberosity. There had been an injection of opaque salts into the gluteal regions since the previous examination.

Fig. 8. Same as in Figure 7, lateral roentgenogram.

Fig. 9. Progression of osteoarthritic changes are noted in anteroposterior view of both knees on May 1, 1946.

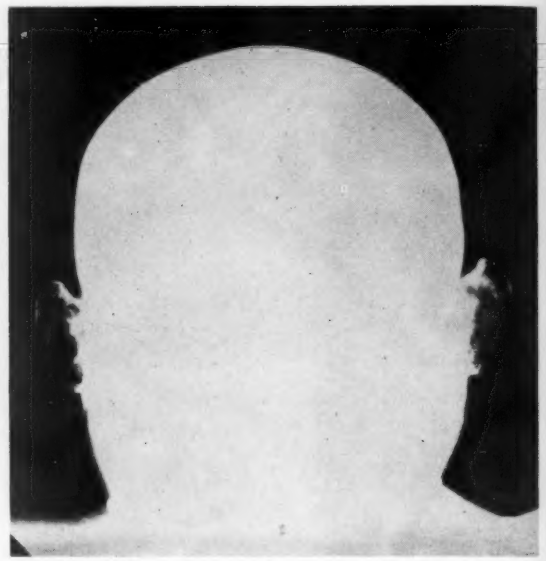

Fig. 11. Roentgenogram showing the extensive calcification of the cartilages of the ears.

The films on May 1, 1946, showed complete fusion of the sacroiliac joints, more calcification about the ischial tuberosities and more sclerosis of the hip joints. There were now calcifications between the greater trochanters and the superior margins of the acetabula. The costal cartilages were noted at this time to be markedly calcified.

Examinations of the knees (Fig. 7, 8 and 9) showed very extensive osteoarthritic changes with marked narrowing of the joint spaces and advanced bony proliferation. No calcification of joint cartilage was recognizable but there were osteocartilaginous bodies posterior to the left knee joint. The changes in the knee joint showed progression between the examinations made in 1937, 1942 and 1946.

The hands (Fig. 10) showed varying degrees of narrowing of the joint spaces of the phalanges and metacarpals, and there were many small cystic areas in the proximal phalanges adjacent to the proximal articular surfaces. No calcification in the articular cartilages and no appreciable new

Fig. 10. Anteroposterior roentgenogram of right hand showing narrowing of joint spaces and small cystic areas near articular surfaces.

bone formation was present. There was extensive calcification of the cartilages of both ears (Fig. 11).

SUMMARY

The history, incidence, clinical, pathologic and roentgen findings of ochronosis are discussed and one new case is added to the literature.

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ROENTGENOGRAPHIC DIAGNOSIS OF SPINAL TUMORS*

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SPINAL tumors run a wide gamut from small to large, intramedullary to extradural, benign to malignant. All categories, however, can be serious. All are important to the patient, particularly if they cause pressure on the spinal cord or on one of the nerve roots. The radiologist must therefore be alert and use every means at his command to identify a lesion as early as possible so that a surgeon may relieve any pressure which is taking place before irreversible changes occur in the nervous tissue.

Our experience is based on a review of all neoplasms of the spine diagnosed at the Cleveland Clinic during a seven year period from 1949 to 1955, inclusive. To this study has been added the one previously made at the Cleveland Clinic by Hannan, Hughes and Mulvey[2] in 1949. The tumors found in both series are summarized in Table I.

TABLE I

HISTOLOGIC CLASSIFICATION

	Present Series	Hannan *et al.*	Total
Neurofibroma	27	30	57
Meningioma	25	22	47
Ependymoma	5	10	15
Glioma	10	6	16
Cyst	2		2
Mixed tumor (teratoma)	3	2	5
Lipoma	1		1
Vascular tumor	3	1	4
Chordoma	6		6
Giant cell tumor	1		1
Aneurysmal bone cyst	1		1
Sarcoma	4		4
Lymphoma	8		8
	96	71	167

PLAIN ROENTGENOGRAMS

Primary spinal tumors, in contrast to metastatic lesions, are in most instances not evident on plain roentgenograms of the spine. In a minority of cases, however, careful roentgenographic study will yield clues (Table II).

Erosion of any part of a vertebral body or neural arch is evidence of an expanding lesion (Fig. 1 and 2). *Infiltration* of the bone is more common in generalized conditions such as metastasis, multiple myeloma or lymphoma, but may at times be found in a localized lesion (Fig. 3–5). *Calcification* within the spinal canal is rarely recognizable, but when seen is almost certainly due to the presence of a meningioma (Fig. 6). Finally, the presence of a localized soft tissue density adjacent to the spine, particularly when eccentric and adjacent to an area of bone erosion, is almost pathognomonic of a neurofibroma or neurilemmoma (Fig. 7).

If good visualization of a suspect area cannot be obtained with conventional anteroposterior and lateral roentgenograms, oblique views may be helpful, particularly

TABLE II

No. Tumors		Diagnosed by: Plain Roentgenograms	Diagnosed by: Myelograms
32	Extradural	23	22
53	Intradural	9	47
11	Intramedullary	0	7
96		32	76

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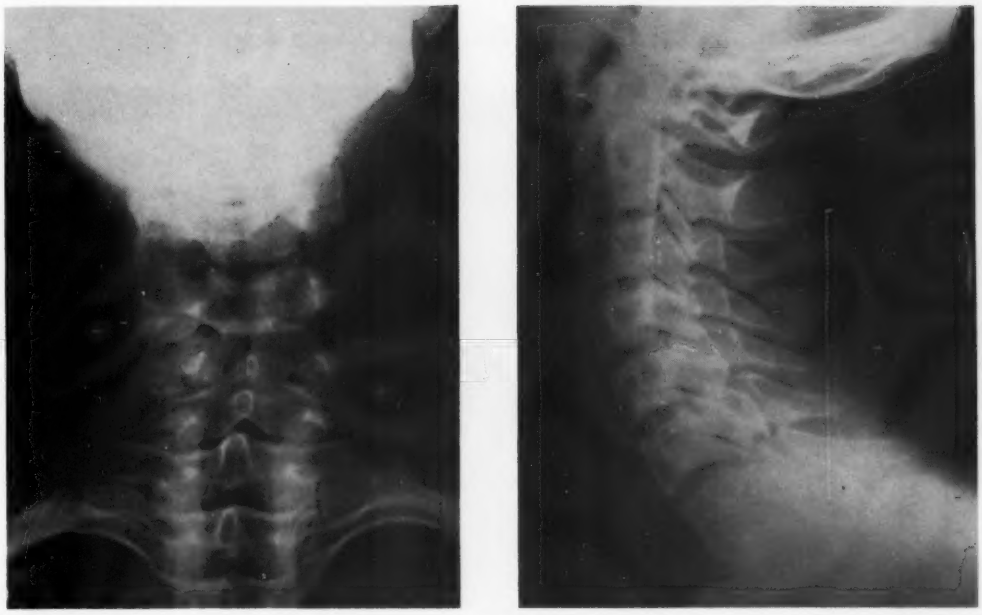

FIG. 1. Neurofibroma of right fifth cervical nerve. The patient, a man aged twenty, had had interscapular pain and weakness for a period of one year, poor control of his legs, and tingling in his arms, legs, and body. Physical examination showed analgesia below C5–6, bilateral Hoffmann and Babinski signs, a spastic gait, and pronounced atrophy of the shoulder muscles. The cerebrospinal fluid protein level was 479 mg. per cent. Laminectomy disclosed a dumbbell tumor, the intradural portion of which was 6 cm. long, the extradural part 2 by 3 cm. The area of bone erosion is shown very indistinctly overlapping the body of C5 on the lateral film; however, is quite evident as a radiolucent defect overlapping the right lateral portions of C4 and 5 on the anteroposterior roentgenogram.

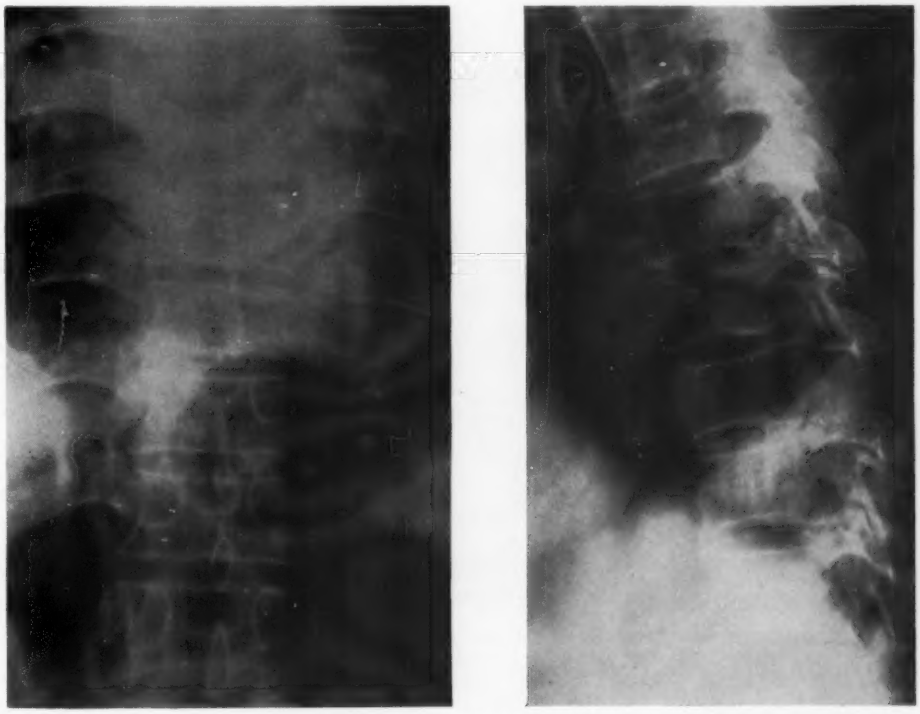

FIG. 2. Plasma cell myeloma, T9. The patient, a man aged sixty-eight with Parkinson's disease, had had pains in the shoulders, arms, low back, and hips for a month. He was anemic, having a hemoglobin of 11 gm. per 100 cc. His serum protein ratio was reversed, the albumin being 2.9 mg. per cent, the globulin 5.2 mg. per cent. Bone marrow aspiration and biopsy of the sternum were not diagnostic. Because of definite evidence of cord compression, a thoracic laminectomy was performed, which revealed huge tumor masses in the spinal canal and bones about T9. Both anteroposterior and lateral roentgenograms show complete destruction of the pedicles of T9.

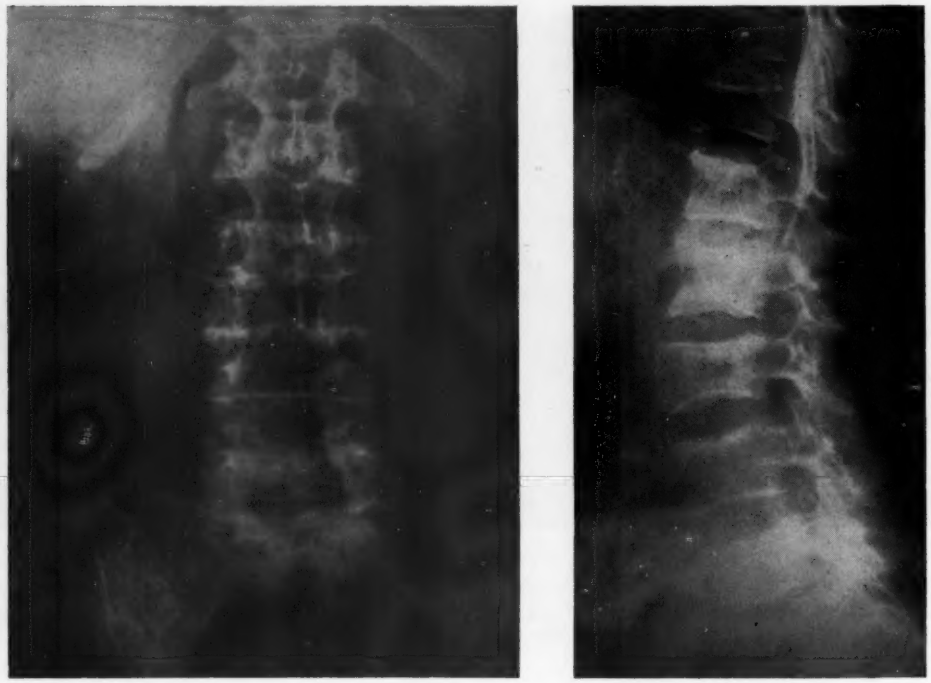

FIG. 3. Multiple myeloma, advanced. The patient, a woman aged sixty, complained of feeling weak and run down for a period of a year. A bone marrow aspiration showed approximately 50 per cent cells of the plasma cell series.

in the cervical and lumbar regions. Occasionally, angulating the roentgen beam will provide more detail of poorly visualized structures. Figure 6 shows a laminagram made to demonstrate intraspinal calcification.

USE OF CONTRAST MEDIA

When symptomatology or neurologic examination is characteristic of a spine lesion but roentgenograms fail to reveal it, myelography is indicated—particularly if there is a positive Queckenstedt test or an elevation of the cerebrospinal fluid protein. Myelography is most likely to be helpful with intradural lesions (Table II).

Injection of a contrast medium into the lumbar subarachnoid space is usually accomplished without difficulty. Figure 8 shows an intradural extraspinal lesion demonstrated by this method. The tumor proved to be a meningioma, which is rare in the lumbar region.

Examination of the thoracic or cervical areas requires more skill and is considerably facilitated by the use of a tilt table which permits fluoroscopy in Trendelenburg position of up to 60 degrees. The cervical spine is sometimes the site of meningiomas (Fig. 9), but they are found much more frequently in the thoracic spine (84 per cent).[5]

Figure 10 shows the intradural lesion produced at T12 by a neurofibroma. In order to outline the upper border of the tumor, additional pantopaque was injected into the cisterna magna and films were made with the patient upright (Fig. 11). Figure 12 shows how a cisternal myelogram was used to help decide the extensiveness of a lesion which caused a patient to be paralyzed, yet was demonstrated on roentgenograms only as a compression of the body of L1. The arrest of the medium at the upper margin of T10 indicated that a large soft tissue component which obstructed the spinal canal was present.

Air can be put to good use as a contrast medium in the spine, particularly in the cervical region. The pneumoencephalogram in Figure 13 showed no intracranial lesion,

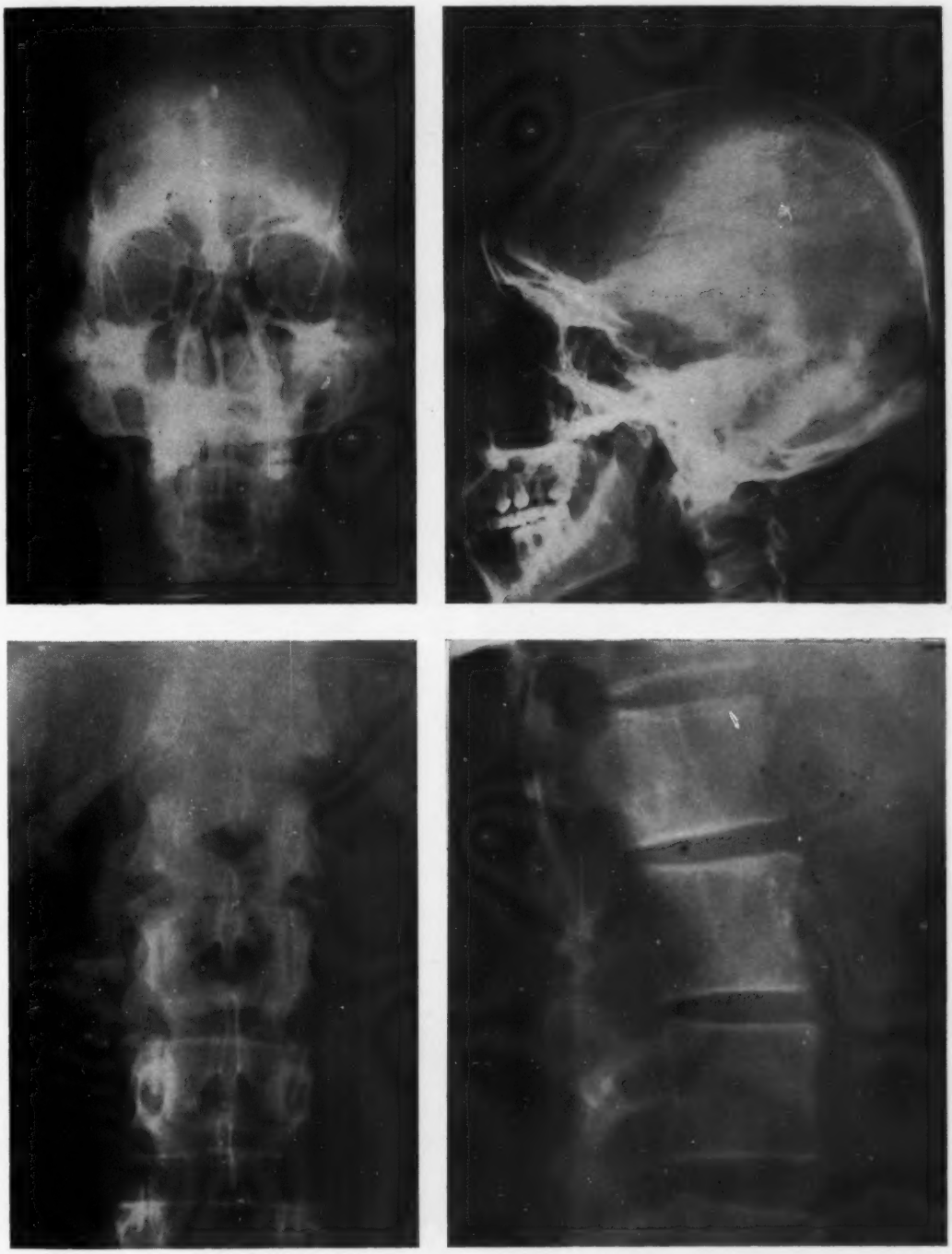

Fig. 4. Hemangiopericytoma. The patient was a man, aged thirty-eight, whose skull roentgenograms showed an indistinct radiolucent defect in the left frontotemporal region, unchanged from an examination four years earlier. On the first admission in 1951, the patient had a hemangiopericytoma removed from his left temple. In 1955, he returned complaining of pain in the back and leg. The roentgenograms of the lumbar spine showed infiltration of the posterior part of the body of L_2, which unfortunately was overlooked because attention was focused on a spondylolysis of L_5 which also was present. The lumbosacral spine was fused.

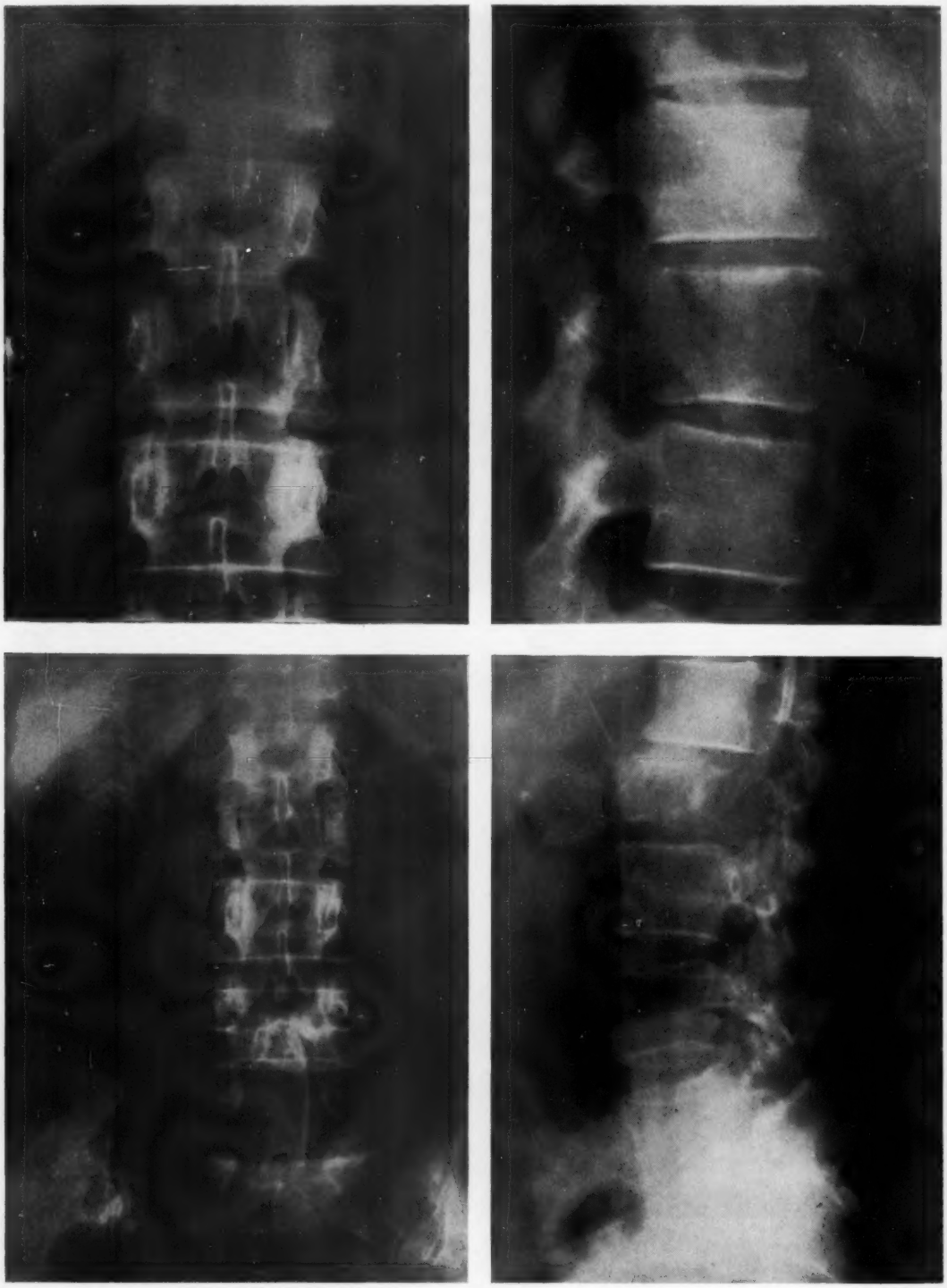

FIG. 5. Hemangiopericytoma, metastatic to L2. Same patient as in Figure 4. The patient's symptoms increased following spinal fusion. The two upper roentgenograms were made four months later, the two lower nine months after surgery. They show progressive infiltration and destruction of L2. A biopsy was performed, which showed a tumor similar to that removed from the left temple in 1951.

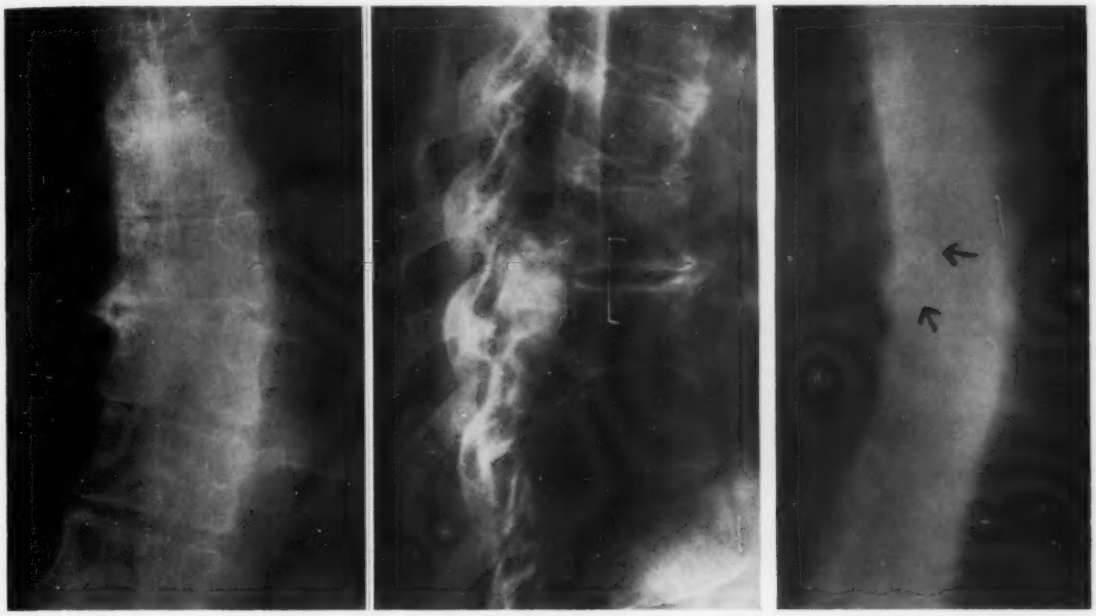

Fig. 6. Meningioma, T8–9. The patient, a woman aged fifty-one, had had a limp of the right extremity for twenty years which progressively became worse, and back pain of several months' duration. The right leg was found to be definitely weak, and the patient dragged it when walking. Babinski signs were present bilaterally, more pronounced on the right. Laminectomy revealed an intradural stony-hard mass on the right, which compressed the cord to about one quarter its normal size. Anteroposterior and lateral roentgenograms showed a scoliosis of the thoracic spine to the left. The large dense oval area of calcification is seen on all three films, but perhaps best outlined in the laminagram made 5 cm. above the table top.

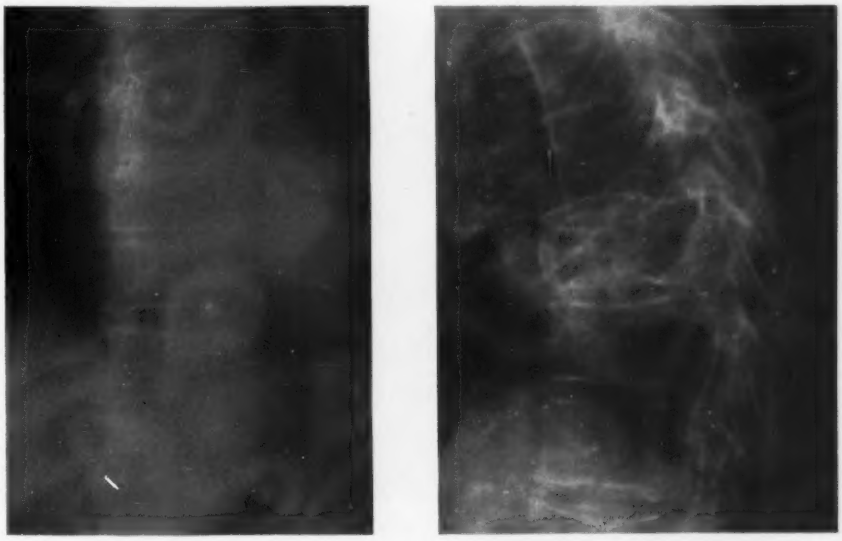

Fig. 7. Neurofibroma, T7. The patient, a woman aged fifty-six, had had pain in the left flank for more than five years. No relief was obtained from wearing a brace or taking stilbestrol. A lumbar puncture showed a spinal fluid protein of 120 mg. per cent. At laminectomy a large dumbbell tumor was found, diagnosed pathologically as a neurilemmoma. The roentgenograms show infiltration, erosion, and a soft-tissue mass extending to the left of the spine.

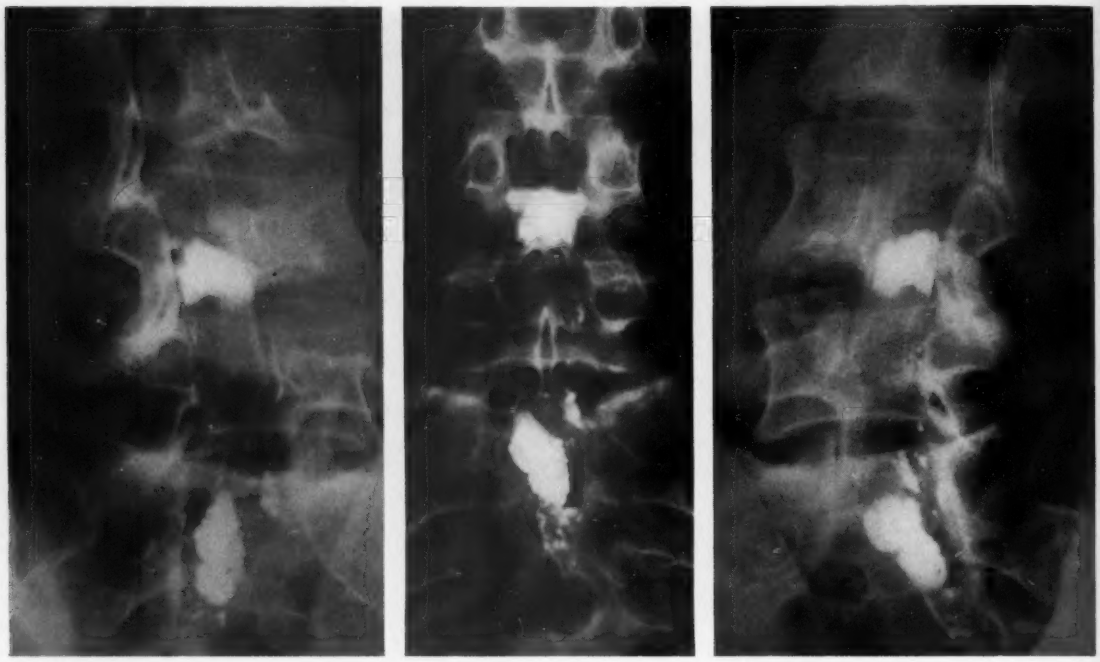

FIG. 8. Meningioma, L5. The patient, a woman aged thirty-nine, had had pain in the left leg for more than one year. A disk protrusion was suspected, but diskography revealed no evidence of such. The cerebrospinal fluid protein level was 125 mg. per cent. The myelogram showed a large intradural tumor of the cauda equina.

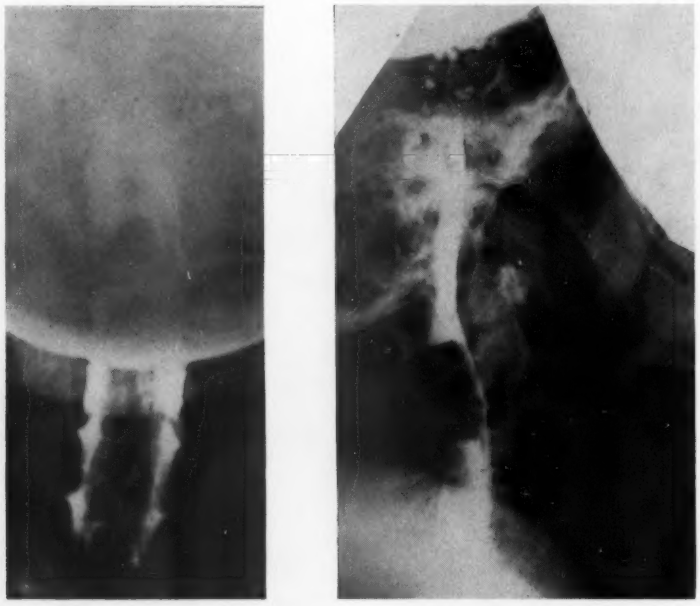

FIG. 9. Meningioma, C2. The patient, a woman aged fifty-two, had been treated four years for an "extracranial vascular headache." In spite of physical therapy, amytal, co-pyronil, and vitamin B_{12}, she developed pain and numbness in the arms. There were no abnormal neurologic findings, and the cerebrospinal fluid protein level was only 57 mg. per cent. She was considered to have a conversion neurosis and given thorazine, without benefit. A repeat lumbar puncture, six months after the first, showed a protein level of 62. Myelography was then decided upon, which revealed the large filling defect below the occiput which is illustrated above.

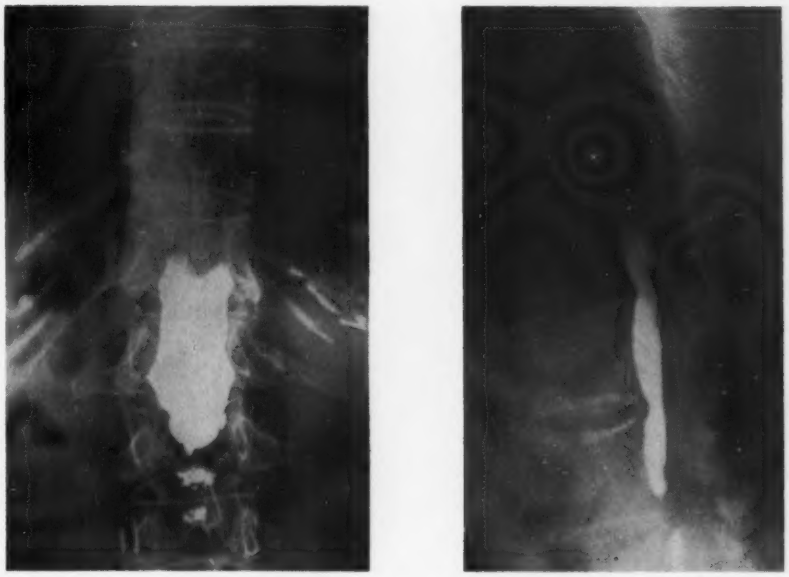

Fig. 10. Neurofibroma, T11–12. A female patient, aged sixty-one, complained of low back pain for a period of a year, which was occasionally sharp "like a toothache." There was a level of sensory impairment at T9–10, and the ankle jerks were absent. The cerebrospinal fluid protein was 201 mg. per cent. The lumbar myelogram showed a complete obstruction opposite the body of T12.

but the absence of subarachnoid air below the foramen magnum is an indication of a massin the area. Unfortunately this lesion was not recognized, and the patient underwent surgery for a protruded disk at the C5–6 interspace. After his symptoms recurred a pantopaque myelogram was obtained (Fig. 14), which indicated clearly the meningioma at C2.

Other contrast media may occasionally aid in making a diagnosis. The patient with a hemangiopericytoma in the spine (Fig. 4–5) would have been diagnosed much earlier and spared a laminectomy and fu-

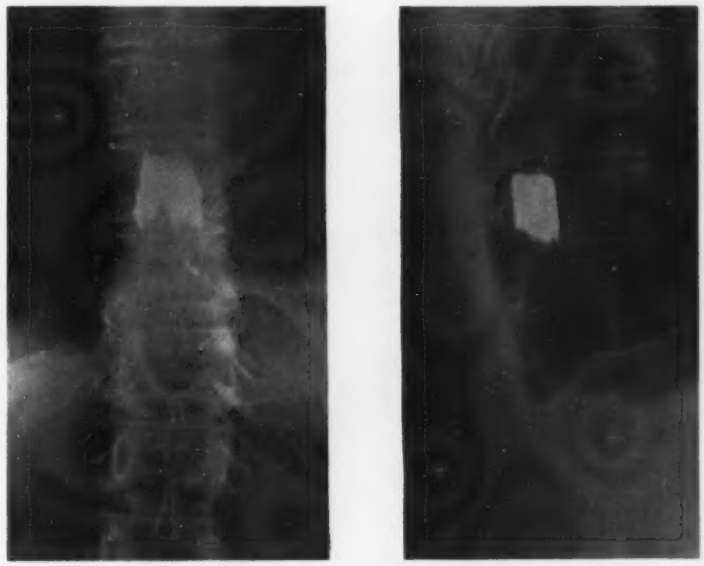

Fig. 11. Same patient as in Figure 10. Pantopaque which had been injected into the cisterna magna was arrested opposite the lower part of T11. The histologic diagnosis was neurilemmoma.

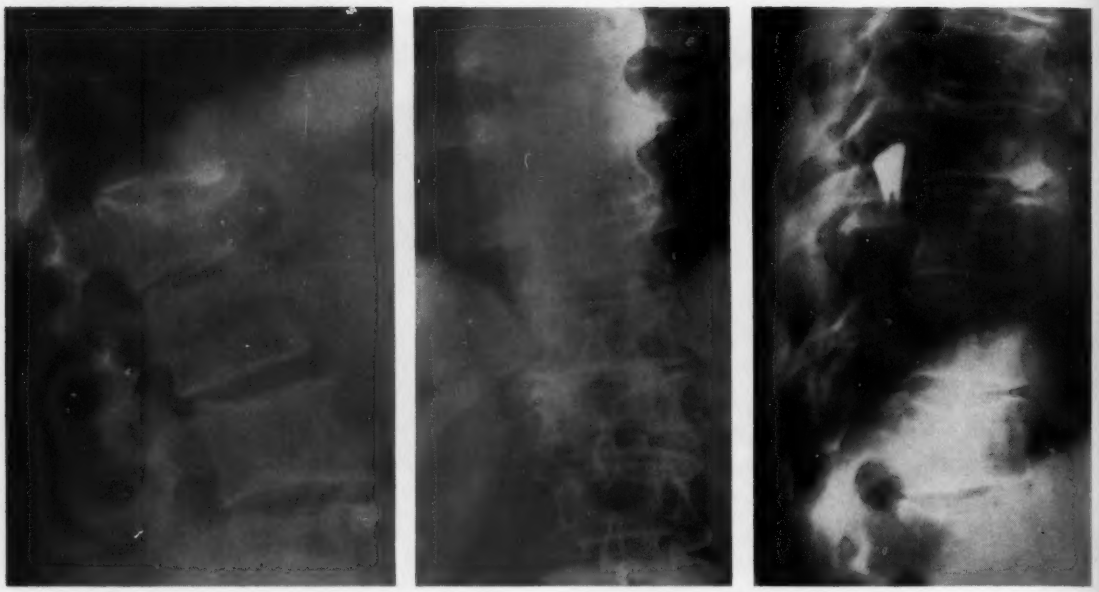

FIG. 12. Plasma cell myeloma. The patient, a woman aged sixty-five, complained of inability to walk for four weeks' duration. She had a motor weakness of the legs, and impaired sensory perception below the umbilicus. A laminectomy disclosed a very extensive tumor which on biopsy proved to be a myeloma. A myeloma had not previously been suspected because roentgenograms demonstrated only the collapse of L1. The cisternal myelogram, however, showed arrest of pantopaque at the ninth thoracic interspace. A bone marrow aspiration, performed after the laminectomy, indicated that the marrow was composed almost entirely of plasma cells.

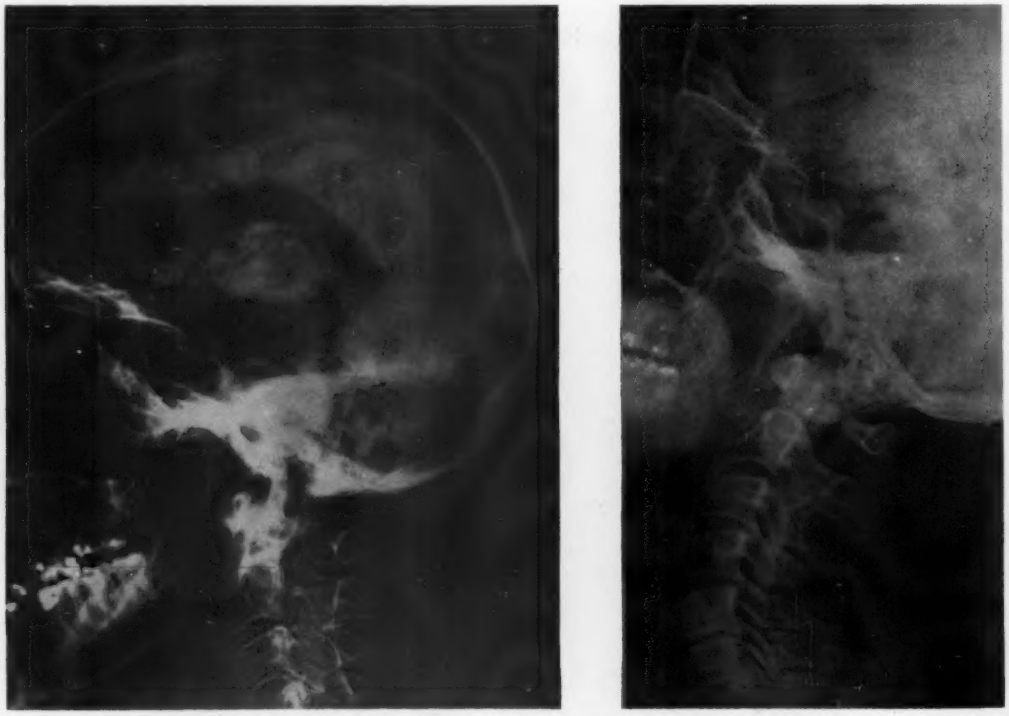

FIG. 13. Meningioma, C2. The patient, a man aged forty-nine, had a history of weakness of the right extremities and right suboccipital soreness for three or four months, clumsiness of the right hand and burning of the dorsums of the hands and feet for one month, and a dull ringing in both ears for many years. Neurologic findings were equivocal. The pneumoencephalogram showed no definite intracranial lesion. Because of the possibility of a cervical lesion, an additional roentgenogram of the neck was made at the time of encephalography, but we failed to recognize the significance of the absence of air from the suboccipital area and therefore overlooked the tumor (which, in point of fact, is rather well outlined on the first film). The subarachnoid air column was seen to be somewhat incomplete opposite C6, so laminectomy was performed at that level. A rather prominent disk protrusion was removed at C5–6, and a lesser one at C6–7.

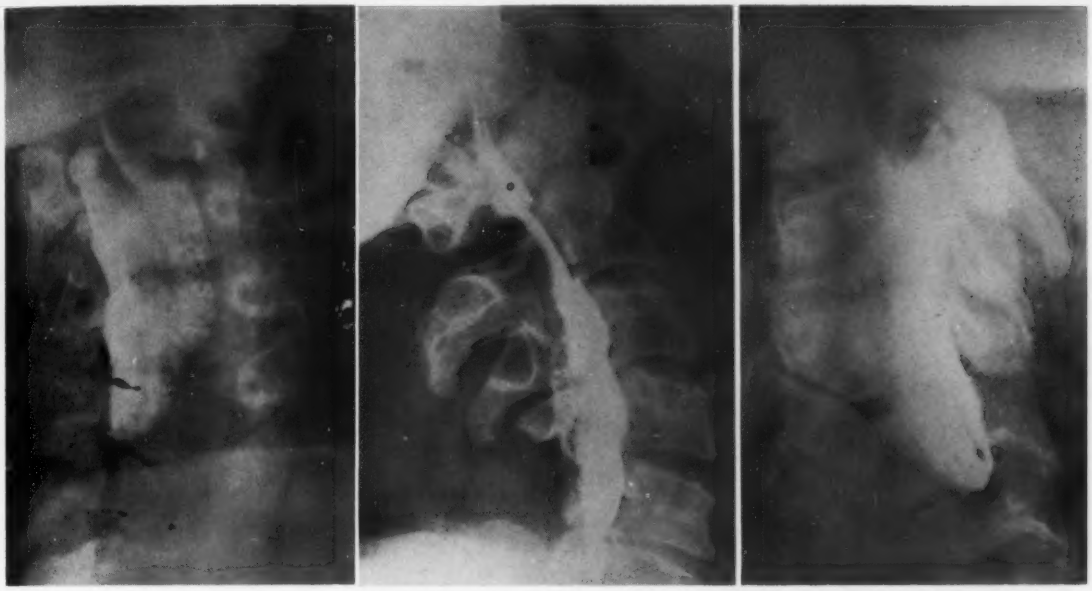

Fig. 14. Same patient as in Figure 13. Following cervical laminectomy, C_4–7, the patient was relieved for four or five months, after which time his symptoms recurred. Ten months after surgery myelography was performed, which revealed the rounded intrathecal tumor shown above.

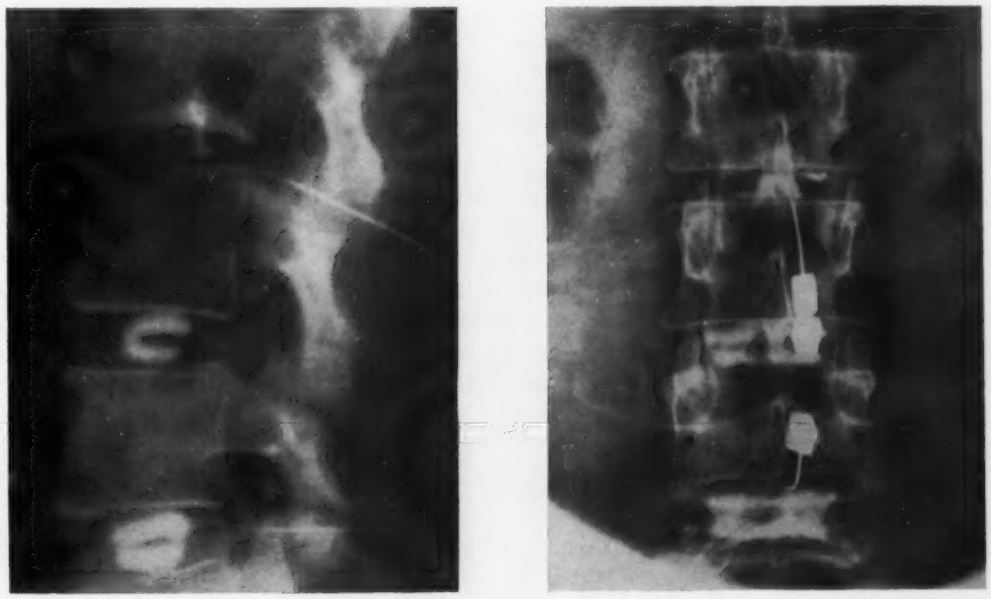

Fig. 15. Hemangiopericytoma, metastatic to L2. Same patient as in Figures 4 and 5. Injections of diodrast had been made into the second, third, and fourth lumbar interspaces. The latter two show the normal bilocular character of intact intervertebral disks, but the diodrast in the second lumbar space shows a definitely abnormal pattern, with penetration of the second lumbar body.

FIG. 16. Syringomyelia. The patient, a woman aged forty-seven, had had difficulty in walking for two years. On lumbar puncture, the Queckenstedt test indicated the presence of a partial block. Pantopaque which was injected into the cisterna magna appeared strung in droplets along the thoracic spine to the level of T12. A laminectomy was performed at T11, where the spinal cord was found to be enlarged and somewhat soft. A needle aspiration of the cord at this level resulted in the withdrawal of 12 cc. of fluid. The anteroposterior roentgenogram of the spine indicated a flattening of the left pedicle of T12, and possibly also thinning of the pedicles of L1.

sion for disk protrusion if we had noticed that the injection of iodopyracet (diodrast) 35 per cent at the second lumbar interspace had entered the body of L2 (Fig. 15).

DIFFERENTIAL DIAGNOSIS

Care must be exercised in the diagnosis of spinal tumors. That erosion of a pedicle is not always an indication of a neoplasm is shown in a case of hydromyelia (Fig. 16). Myelograms also are prone to faulty interpretation. One of the more common errors is caused by attempting to interpret defects which appear in the column of the contrast medium following subdural or

FIG. 17. Congenital anomalies. The patient, a boy aged six, was examined because of urinary incontinence from birth. The anteroposterior roentgenogram showed incomplete formation of the sacrum, and no coccyx.

epidural injection. Even when the injection is subarachnoid, there may be simulation of a tumor by hematoma, arachnoiditis, abscess, arthritis, or protruded intervertebral disk. We have seen 12 instances of complete obstruction of the spinal canal by disk protrusions, including 2 in which part of the disk material had penetrated into the dura.[4]

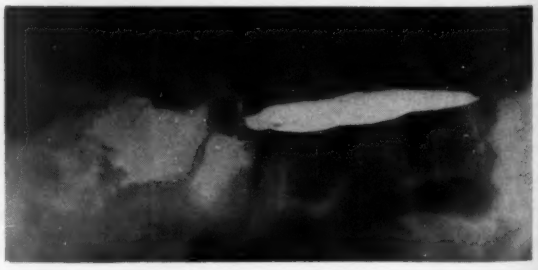

FIG. 18. Same patient as in Figure 17. The lateral film made at the time of myelography showed very clearly the absence of development of any spinal segments distal to S2.

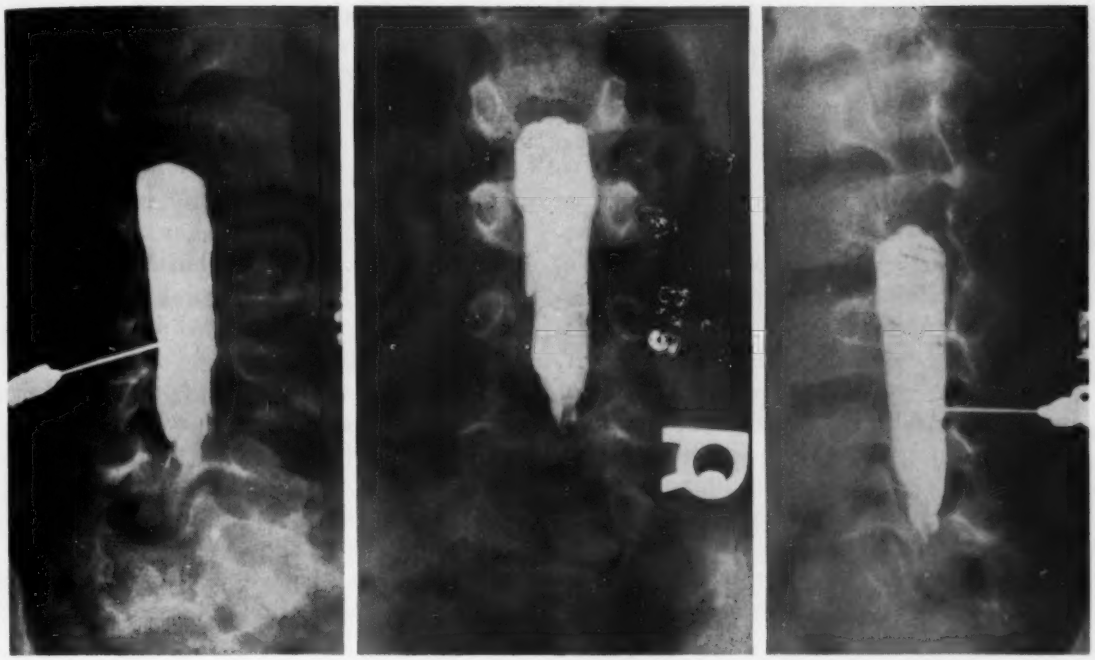

Fig. 19. Same patient as in Figures 17 and 18. Myelograms made upright showed a congenitally short caudal sac, which terminated at the upper part of L5. Exploration of the sacrum was made, looking for a teratoma or other tumor, but nothing was found other than an unusually large epidural fat collection.

Special attention must be directed to the caudal sac, which varies considerably as to position and shape. A high termination of the caudal subarachnoid space may be the result of a congenital anomaly, particularly if other anomalies are present (Fig. 17–19).

SUMMARY

1. The subject presented is based on a review of 167 cases of spinal tumors studied at the Cleveland Clinic.

2. Plain roentgenograms may reveal erosion or infiltration of bone, rarely calcification of the tumor or the presence of an extraspinal mass. Special procedures, including laminagraphy, are helpful in establishing a diagnosis. One third of our cases showed abnormalities on plain roentgenograms.

3. Myelography may be performed by introduction of iodized oil either into the lumbar subarachnoid space or the cisterna magna. Diagnosis in selected cases is aided by air myelography or diskography. Myelography aided in making the proper diagnosis in 76 of 96 spinal tumor patients in the past seven years.

4. Errors in technique, effects of trauma, infections, arthritis, protruded intervertebral disks, and congenital anomalies may lead to mistaken interpretation of myelograms.

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ROENTGEN MANIFESTATIONS OF EPIDERMOLYSIS BULLOSA*

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IN RECENT years many articles have been published dealing with the roentgen manifestations of certain skin diseases, especially scleroderma, sarcoid, and adenoma sebaceum. There are only 2 case reports in the radiologic literature, however, dealing with the visceral complications of epidermolysis bullosa, and both are in a foreign language.[15,26] The roentgenographic features of epidermolysis bullosa are not mentioned in any American book on radiology, dermatology, or gastroenterology. A comprehensive presentation of the roentgen aspects of this disorder has never been recorded.

Radiology first played a part in the history of epidermolysis bullosa in 1906, when Berger[1] treated the cutaneous bullae with roentgen therapy. Although this first patient evidently improved, other dermatologists[6] were not convinced of the value of this method. In 1906 Nobl[17] found that roentgen diagnosis was a useful adjunct in the examination of his patient. The roentgenograms revealed shortening and atrophy of the terminal phalanges of the hand. Narrowing of the esophageal lumen (a fluoroscopic observation) was reported by Steurer[25] in 1921. In 1925 Kaftan[5] described advanced caries in a patient and published the first dental films on this disease.

The roentgenologic examination has definite value in diagnosing changes in the skull, long bones, teeth and esophagus. Alterations in the shape and size of the skull have been described, consisting of turricephaly,[12] and microcephaly.[27]

Abnormalities of the extremities have also been noted. The long bones may be slender.[21] Serious deformity of the hands may occur due to marked flexion contractures of the metacarpophalangeal and the interphalangeal joints, thereby producing a claw hand or closed-fist configuration.[7] An additional complication is acquired webbing of the fingers. This is produced by epithelial bridging and synechiae between adjacent fingers, which had been simultaneously involved by bullae. This process may extend to the point where the entire hand is encased in a complete pouch or "glove" of skin, through which the fingers may be dimly visible.[24] Similar changes may occur in the toes. The distal phalanges may be shortened or even amputated by the extensive soft tissue atrophy and scarring.[9] Infection and ulceration may lead to marked loss of soft tissue and bone.[4] In some cases the frontal view may show little change in the ungual tufts, and yet the sagittal projection often delineates a characteristic wedge-shaped thinning of the anteroposterior diameter of the distal phalanx.[26] In one case tiny soft tissue calcifications were present in the finger tips.[26] Retarded epiphyseal development has also been documented.[7]

The esophageal manifestations are important to the radiologist, since patients with dysphagia will be referred to the radiologic department for a barium meal study. Out of a total of 11 reported cases with this complication, only 5 had a roentgen examination. In 1 patient the study is said to have been of no help, but in the other 4 a narrowed segment of the esophagus was demonstrated.[11,15,16,25] The site of the stenotic segment has varied from the cervical portion of the esophagus to the lower end. Moderate dilatation of the esophagus proximal to the canalized region has been observed.[15] The contour of the involved area is usually smooth or only slightly irregular. Above and below the lesion there is a gradual tapering of the barium column.

Dental changes may be severe and may

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lead to early loss of many teeth due to rampant caries.[14] Defective development of the dental structures has been noted, with transverse erosions of the enamel.[20] The teeth are often brittle or so soft that they are rapidly worn down to the roots. Marked irregularity in the shape of the teeth, hypoplasia, and hyperplasia have also been observed.[22] Only one article[5] has an illustration of the dental roentgenograms in this disease. The roentgen features are loss of the teeth, presence of marked caries, periapical abscess formation, jagged contours of the crowns and retained roots.

One aspect of epidermolysis bullosa that would interest the radiotherapist is the occurrence of carcinoma of the skin and tongue. A twenty-five year old female patient[8] had skin, tongue and oral mucous membrane bullae since the third day of her life. When she sought medical advice because of glossodynia, an inoperable squamous cell carcinoma of the tongue was found. Another unusual case is that of a twenty-six year old man[2] who developed a squamous cell carcinoma of the forearm. Roentgen therapy did not control this malignancy, and an amputation above the elbow was necessary. Five other cases of skin cancer have been recorded,[3,18,19,23] all of these lesions being situated on the legs. This localization is striking, for only 2 per cent of cutaneous malignancies in the general population affect this area.

In 3 patients roentgen therapy was attempted, but failed to cure. The radioresistance of cutaneous carcinoma in epidermolysis bullosa coincides with that of scar cancer in general. The lack of response to ionizing radiation is probably associated with the avascular tumor bed and its relative anoxia. While an occasional case of cancer developing in a scar can be successfully managed with roentgen therapy, it is generally agreed that surgery is the treatment of choice.

In 4 of these cancer cases[3,18,19] roentgen changes were present in the tibia, consisting of irregular periosteal new bone formation, cortical thickening and sclerosis. Calcification of the interosseous ligament was also observed.[19] These alterations, of course, are nonspecific and may be observed in a chronic leg ulcer.

REPORT OF A CASE

M.G., a white male, was born in 1923 with cutaneous bullae on his legs. Twenty-four hours later bullae covered his entire body. Bullae also involved the mucous membranes of the mouth, nose and pharynx. There was a definite delay in development. The permanent teeth were irregularly formed and were so brittle that fragments would break off during eating. When examined at the age of fourteen, he was found to be emaciated. Some of the toes had acquired webbing.

At the age of twenty-one the remaining teeth had to be extracted because of marked caries. When he was twenty-four, flexion contractions in the interphalangeal joints of the hands were noted. A twenty degree loss of extension at each elbow joint was evident.

At the age of twenty-seven the patient complained of increasing dysphagia. This difficulty in swallowing had been present intermittently since childhood. On examination the fingers were webbed up to the proximal interphalangeal joints. Roentgen examination at this time revealed transient narrowing of the distal third of the esophagus. At the age of thirty the patient was esophagoscoped by Dr. Brunelle (October 6, 1953). At about the level of the aortic arch, the mucosa was found to be very friable, red and bled easily. The mucosa had the same aspect all the way down to 37 cm. below the upper alveolar ridge. At that point an esophageal stricture was encountered, which was severely ulcerated and bled very easily. Immediately past the stricture, gastric mucosa was encountered with gastric fluid. The impression of the esophagoscopist was: short esophagus (37 cm.), stricture of the esophagus, esophagitis, and hiatus hernia.

Three months after the esophagoscopy a No. 36 French bougie was passed easily. The esophagoscopist noted some spasm in the upper and middle thirds of the esophagus. Swallowing was improved by this procedure.

A biopsy of a cutaneous bulla was performed at the age of twenty-seven. The pathologic diagnosis by Dr. G. F. Machacek was epidermolysis bullosa.

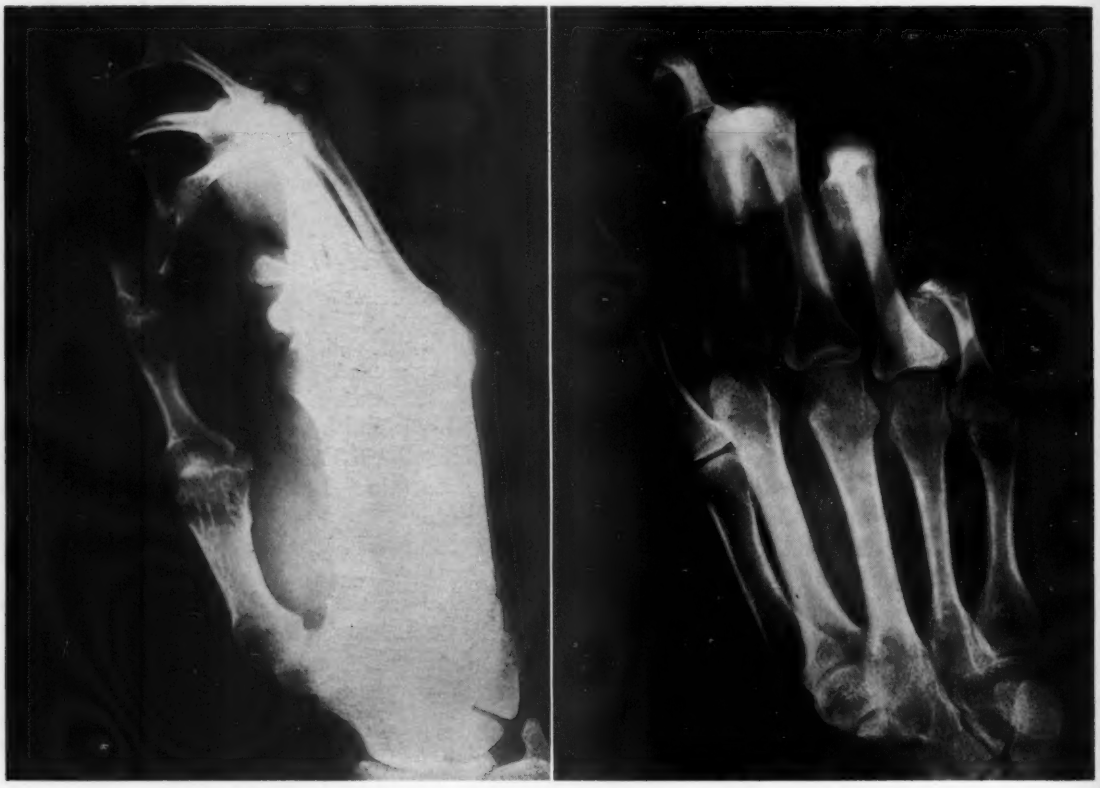

Fig. 1. Flexion contractions at the interphalangeal joints of the lesser four fingers, producing a claw hand. Wedging of the distal phalanges.

Roentgen examination of the teeth at the age of twenty-one revealed the presence of extensive caries. Many teeth were worn down completely, leaving only the roots. Several periapical abscesses were visible.

A barium swallow study at the age of twenty-seven revealed a loss of elasticity of the lower esophageal wall. The lumen of the lower third of the esophagus was transiently narrowed. Three years later a follow-up study was done prior to the esophagoscopy. The narrowing of the distal 4.5 cm. of the esophagus was again demonstrated. The involved segment had smoothly tapering margins, above and below. A hiatus hernia was also noted at this time, due to shortening of the esophagus. Seven centimeters of the fundus had been pulled up into the thorax. The roentgen diagnosis was peptic esophagitis with an acquired, short esophagus type of hiatus hernia.

Fourteen months after the esophagoscopy and bougienage, a progress study again showed the constricting lesion of the lower third of the esophagus and the hiatus hernia. When the barium bolus reached the level of the lesion, a slight increase in the diameter of the lumen took place, indicating the presence of spasm as well as cicatricial stenosis. No definite retardation in the passage of the barium occurred. Peristalsis in the upper two thirds of the esophagus was normal, and there was no dilatation of the esophagus proximal to the stenotic site. The contours of the barium column in the contracted segment were fairly smooth, and the junction with the normal esophagus was conical. Mucosal folds were absent in the involved region. When compared with the previous study prior to the esophagoscopy, there was a slight increase in the length of the constricted segment.

At the age of thirty-three a roentgenographic examination of the entire skeleton was carried out. The skull roentgenograms revealed the presence of large frontal sinuses. The mandible was markedly prognathous, the symphysis menti protruding 5 cm. anterior to the alveolar ridge of the maxilla. The body of the mandible was lengthened and the angle was increased. The maxilla was moderately hypoplastic. A

Fig. 2. Acquired webbing of the third, fourth and fifth toes of the right foot. Flexion contractions at the interphalangeal joints.

study of the long bones revealed overconstriction of the shafts of the humerus, radius, ulna and fibula. The length of the long bones, however, was normal. The clavicles were thin. There was no significant demineralization of these structures. There was a marked decrease in the volume of the soft tissues in the upper arm and forearm. The subcutaneous fat of the upper extremity was reduced to a 1 mm. layer.

A comparison with normal individuals indicated that the decreased caliber of the shaft of

Fig. 3. Esophagram of patient at age thirty-three. Narrowed segment at the lower end of the esophagus with traction type of hiatus hernia.

Fig. 4. Mandible of patient at age thirty-three. Marked prognathism due to elongation of the body of the mandible, an increase in the mandibular angle and slight hypoplasia of the maxilla.

FIG. 5. Dental film of right molar region of maxilla. Large periapical abscess. Crowns destroyed by caries and abnormally rapid attrition.

the radius, ulna and clavicle was predominantly caused by a diminution of the width of the medullary cavity, the thinning of the cortex playing a lesser role. In the case of the humerus and fibula, however, the narrow shaft could be attributed equally to a reduction in both the cortex and medulla. The femur and tibia had a normal over-all transverse diameter, but there was more medulla and less cortex than usual. These complex bone changes were evidently secondary to the long-standing muscular hypoplasia, atrophy, and decreased activity, starting in early childhood. The attenuated muscle stresses placed upon the long bones probably accounted for the diminished transverse growth of the shaft. The longitudinal growth, however, has remained normal.

The hands presented the most striking alterations. Definite acquired webbing was present between the lesser four fingers almost up to the proximal interphalangeal joints. A claw-hand deformity was present due to flexion contraction at the interphalangeal joints of the lesser four fingers. The shafts of the phalanges were slender. Slight demineralization of the metacarpals and phalanges was noted. When the terminal phalanges were visualized in the lateral view, definite wedging was noted because of the decreased anteroposterior diameter. Only slight flattening of some of the ungual tufts was noted in the frontal projection.

A slight coxa valga (145 degrees) existed bilaterally. The roentgenograms showed a considerable decrease in the muscle mass of the calf, as well as a very thin layer of subcutaneous fat.

Roentgenograms of the right foot demonstrated extensive webbing between the third, fourth and fifth toes. On the left side the fourth and fifth toes were webbed. The shafts of the second through the fifth metatarsals of each foot were slender. A similar finding was present in the proximal phalanges of the second through the fifth toes. Flexion contractions were present at the proximal interphalangeal joints of the lesser four toes bilaterally.

DISCUSSION

Including the case presented in this article, a total of only 18 cases of epidermolysis bullosa has been described with positive roentgen findings in either the extremities or the esophagus. Of the eighteen patients, 13 had roentgen changes limited to the hands or feet, while 4 had roentgen changes limited to the esophagus. Our patient is unfortunately unique in that he had serious alterations in both the bones and the esophagus.

The overconstricted shaft of the long bones has been previously mentioned in only a few cases.[21] In addition to severe congenital malformations of the central nervous system with paralysis, other conditions starting in childhood may produce constriction of the shafts of the long bones and would therefore be considered in differential diagnosis: progressive muscular dystrophy, poliomyelitis, osteogenesis imperfecta, dermatomyositis, rheumatoid arthritis juvenilis, Werner's syndrome, arthrogryposis congenita, tuberculosis of the hip, severe talipes equinovarus, and pyogenic arthritis of the tarsal bones.

The roentgenogram of a single digit of a patient with epidermolysis bullosa might resemble osteomyelitis, scleroderma, Raynaud's disease, tabes dorsalis, syringomyelia, psoriasis, neural leprosy, osseous glanders, cleidocranial dysostosis, acro-osteolysis, congenital ichthyosiform erythroderma, developmental abbreviation of the phalanges and progeria.

The deformed hand secondary to a mutilating rheumatoid, psoriatic, or gouty arthritis should usually not give any dif-

ficulty in differential diagnosis from epidermolysis bullosa, for in these diseases marked destructive changes in the joints will be evident. Other than flexion contractions and subluxations, no significant roentgen changes in the joints have been observed in epidermolysis bullosa.

The claw hand and wedging of the distal phalanges are probably secondary to marked soft tissue scarring with obliteration of blood vessels. For this reason similar alterations in the bones of the hand may occur with severe burns. Frostbite may also produce late bone destruction of the distal phalanges of the toes associated with soft tissue loss. The combination of acquired webbing, wedging of the distal phalanges, and a claw (or closed-fist) deformity is evidently seen only in epidermolysis bullosa.

The altered configuration of the maxilla and mandible in our patient is of special interest as there is little information on this point in the literature. A few authors, however, have commented on the presence of malocclusion,[25] deformed dental arches,[21] or atrophy of the jaw.[13]

When the mandible is studied according to Lönberg's method of mensuration, the marked mandibular prognathism is shown to be due to a combination of a hypoplastic maxilla together with an elongated mandibular base. The angle of the mandible is also slightly increased. These osseous transformations may be the result of long-standing muscular atrophy, for an obtuse mandibular angle has also been observed in pseudohypertrophic muscular dystrophy and in dystrophia myotonia. Of course, other diseases may cause a protruding lower jaw, as, for example, acromegaly, achondroplasia, cleidocranial dysostosis, and craniofacial dysostosis. While in acromegaly the mandible is actually elongated, in achondroplasia the mandibular protrusion is due to a hypoplastic maxilla.

The esophageal manifestations of our patient are somewhat similar to those described in the patient of Meyer-Krahmer and Schwab. The roentgen localization of the narrowed segment to the lower third is identical. In both cases the esophagoscopic findings indicated involvement of the middle third as well as the lower third. Schwab, however, found vesicles, mucosal erosions covered with fibrin, and spasm. In our case no vesicles were visible, but the mucous membrane was severely altered by esophagitis and ulcerations. The films did not demonstrate the ulcers found on esophagoscopy, but this is not unusual. The hiatus hernia demonstrated in our roentgenogram has not been previously reported in epidermolysis bullosa. The acquired shortening of the esophagus evidently led to this "traction" type of hernia.

The roentgen appearance of the esophageal lesion of epidermolysis bullosa is the same as that of peptic esophagitis. The roentgenographic features of peptic esophagitis and its differential diagnosis (benign stricture, neoplasm spasm, varices, scleroderma) are in the standard textbooks. Esophagoscopy is often a necessary part of the study of a patient with esophagitis to detect the presence of ulceration and to rule out carcinoma.

SUMMARY

The appendicular skeleton, the teeth, and the esophagus may show definite roentgen changes in the dystrophic type of epidermolysis bullosa. The hands may have a claw appearance, with acquired webbing. A lateral view of the finger may disclose wedging of the distal phalanges. The shafts of the long bones may be overconstricted. The teeth may be worn down to the roots by abnormally rapid attrition and extensive caries. A stenosing lesion of the esophagus may occur at any level, with a roentgen appearance suggesting esophagitis.

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OSTEOMA CUTIS

A CASE REPORT

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OSTEOMA, or osteosis, cutis denotes the presence of true bone in skin.[1] It probably represents repair of traumatic or infectious diseases with calcification and subsequent heterotopic bone formation.[2] It has been found in the former sites of secondary syphilitic lesions, on the shoulders of hod carriers, in the scar of a laparotomy wound, in pigmented nevus, in acne, and in other situations.[3]

In the present case a white male, aged sixty-five, reported that at about the age of fifteen he had developed warts on the fingers and volar surfaces of the hands. The only treatment was the use of a salve composed of a red oil and sawdust; it is doubtful if this had any effect on the course of the lesions, which disappeared over a period of about five years, to be replaced by dense hard tissue.

On examination numerous small nodules could be seen and palpated in the fingers, and large confluent plaques were observed on the volar aspects of the hands which completely stiffened the affected skin areas. These were ivory-colored and slightly shiny. A biopsy showed the presence of true bone.

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FIG. 1. Osteoma cutis.

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PERITENDINITIS CALCAREA OF THE HAND AND WRIST*

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THE importance of the roentgen examination in the differential diagnosis of localized acute and subacute lesions in the hand and wrist cannot be overemphasized. The identification of amorphous calcium deposits in the soft tissues will often establish the diagnosis of peritendinitis calcarea. This presentation is concerned with the diagnosis of this frequently unrecognized disease and the successful treatment with roentgen therapy.

CLINICAL FINDINGS

Peritendinitis calcarea, the name first proposed by Sandström,[11] has also been described under various synonyms including bursitis calcarea, bursitis calculosa, bursitis with a calcium deposit, tendinitis calcificans, calcifying bursitis and periarthritis calcarea.[2,13]

Reference to the literature regarding peritendinitis calcarea of the hand and wrist indicates the infrequency of the clinical recognition of this entity. King and Mahaffey[5] after a review of 468 cases report an incidence of 1.7 per cent in the hand and wrist. Sandström,[11] in his study of 329 cases, found 2.4 per cent to be located in this area.

Sandström[11] describes the typical picture and the course of the disease, which he divides into acute, chronic and latent forms. The acute form presents the following signs and symptoms: pain, local swelling, point tenderness, restricted mobility, fever, increased sedimentation rate and calcium deposits in the soft tissues. The chronic form presents less pronounced symptoms and signs, but there may be local pain and tenderness, especially upon motion. The latent form is asymptomatic and is incidentally identified roentgenographically as calcium deposits in the soft tissues adjacent to bones and joints. Local redness and increased heat are also found in the acute stage.[2] A good description of the clinical signs and symptoms is presented by Carroll, *et al.*[1]

The clinical picture in peritendinitis calcarea of the hand and wrist may resemble that of acute cellulitis, tenosynovitis, arthritis, osteomyelitis, gout, fracture and early abscess formation. The chronic form may resemble Heberdeen's nodes, ununited avulsion fracture and possibly chalky gout. It is most frequently confused with inflammation but is unlike it in that the pain is more severe, there is no associated laceration, abrasion, lymphadenitis or lymphadenopathy and the location is unusual for tendon sheath or soft tissue compartment infection.[2]

The roentgen demonstration of calcium deposits in the soft tissues of the symptomatic area establishes the diagnosis.[12] Roentgenograms made in the anteroposterior, lateral and oblique projections are often required. Additional tangential projections of the involved area with the wrist in flexion or extension are often necessary to locate a small calcium deposit immediately adjacent to the bone. These calcifications are typically amorphous in character and vary in contour and configuration.[11] They may be visualized as faint linear or irregular lines, multiple small punctate areas of increased density, or globular irregular dense homogeneous masses of varying sizes without trabeculation. A slight tendency toward striation is occasionally seen in the more chronic case. Only very exceptionally, and after many years, do the calcium deposits ossify.[13] Seidenstein's[12] series of 15 cases with localization in the

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hand and wrist exhibited calcium deposits ranging from 3 mm. to 2 cm. in greatest dimensions.

Difficulty may occasionally be encountered in differentiating these calcium deposits from sesamoid bones and avulsion fracture fragments. The configuration, definition, localization and trabeculation in the latter are usually distinguishing characteristics. The localized, soft tissue swelling obliteration of the adjacent fascial planes is almost invariably associated with acute peritendinitis calcarea and is a very useful diagnostic sign.

ETIOLOGY

The etiology remains obscure. Various authors have suggested the following as causative agents: trauma,[2,8] infection and vitamin deficiency,[14] and disturbance of the calcium metabolism.[16] Trauma with a slight tear in the tendon or ligament followed by local necrosis of tissue and subsequent deposition of calcium salts is the most widely accepted theory of pathogenesis.[1,12] Material taken from an acute calcium deposit in the shoulder and injected in the opposite arm has proved extremely irritating to the tissues and has caused a local cellulitis.[7]

PATHOLOGY

Gross examination reveals the calcium deposit to be found within the tendon, the tendon sheath, or in adjacent endothelial-lined soft tissue sac, rather than in actual bursae.[11] Calcification has been described in some instances within the wall of the bursae.

Microscopic examination commonly shows a degenerative change in the fibrous tissue of the tendon, or adjacent capsular or ligamentous tissue, ranging from trivial loss of microscopic detail to true necrosis. Calcium is deposited in these areas in the form of calcium phosphate, oxalate or carbonate, or a molecular combination of these salts. This is apparently related to a deficient blood supply as medial hypertrophy and luminal narrowing is found in the blood vessels. Some areas contain foreign body giant cells and others exhibit evidence of inflammation with cellular infiltration.[2]

REPORT OF CASES

The following 10 cases are presented to review our experience with this disease in the Therapy Division of the Radiology Department at the North Carolina Baptist Hospital and the Bowman Gray School of Medicine of Wake Forest College:

Case 1. R. T. B., a twenty-six year old white male, experienced pain in the left little finger and lower side of the wrist ten days prior to examination. It was first noticed while the patient was working in his garden, and became worse two days prior to admission when he noticed some redness and fullness on the right side of the wrist. There was extreme tenderness and pain when he attempted to make a fist.

The physical examination revealed marked swelling of the distal ulnar side of the left forearm, with exquisite tenderness over the carpal and finger flexors in the ulnar side. Resisted flexion of the third, fourth and fifth fingers produced marked pain in the area of the wrist. The clinical impression was acute tenosynovitis of the left wrist. The wrist and forearm were immobilized in a plaster splint, and the patient was given 400,000 units of penicillin and one gram of streptomycin per day. Roentgen examination on October 29, 1952, revealed amorphous calcification in the soft tissues adjacent to the pisiform bone (Fig. 1*A*).

Roentgen therapy was instituted on October 29, 1952, and three doses of 150 r (in air) each were given. Following the initial treatment the patient noted marked relief of pain. At the completion of the therapy, the symptomatology had disappeared completely.

A re-examination at the end of three years revealed no recurrence of symptoms and there was no evidence of calcification (Fig. 1*B*).

Case 11. A. M. B., a twenty-eight year old nurse, complained of intermittent pain in the right wrist of two weeks' duration. There was no history of injury. Physical examination revealed local tenderness and slight swelling over the right pisiform bone. There was no inflammation or fluctuation. There was a full range of active motion, but some pain was produced by

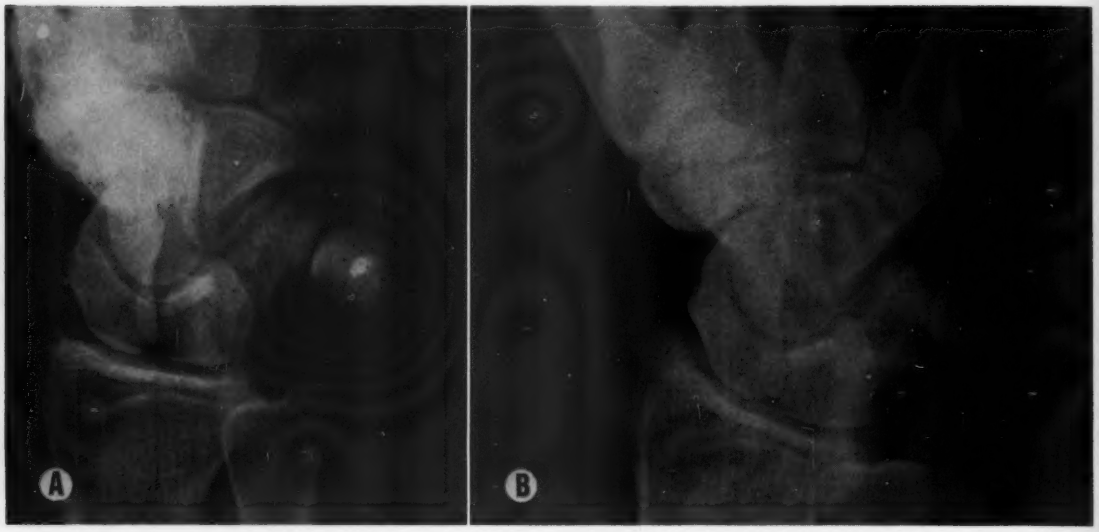

FIG. 1. Case I. (*A*) Peritendinitis calcarea superimposed and adjacent to the pisiform bone. Roentgenogram made prior to roentgen therapy. (*B*) Roentgenogram three years later shows that the previously noted calcium in the soft tissue has disappeared.

passive stretching of the tendons in this area. No diagnosis was made prior to roentgen examination.

A roentgenogram (Fig. 2) of the wrist demonstrated a small calcium deposit in the soft tissues adjacent to the pisiform bone. The patient was given roentgen therapy in the amount of 100 r (in air) every other day for three doses with moderate decrease in the symptomatology one week after completion of therapy.

FIG. 2. Case II. Roentgenogram demonstrating a small area of calcification adjacent to the pisiform bone.

CASE III. B. K., a forty-two year old white housewife, presented herself at the Emergency Room with a three day history of swelling, tenderness and redness over the ulnar aspect of the right wrist. The pain was intensified by movement of the fifth finger. There was no history of antecedent trauma. No clinical diagnosis was made. Roentgen examination (Fig. 3*A*) revealed a small collection of amorphous calcium adjacent the left pisiform bone, and the diagnosis of peritendinitis calcarea was established. The patient received roentgen therapy in the amount of 300 r (in air) in three doses in six days. She was much improved on the second treatment day and was completely relieved of pain at the termination of therapy. There is no evidence of residual calcium (Fig. 3*B*).

CASE IV. R. S., a fifty-five year old white male cotton-mill executive, had a long history of hospital admissions and clinic visits for gastrointestinal disorders and low back pain. He incidentally mentioned on a clinic visit in June, 1951, a pain in the left wrist of six months' duration which occurred with certain motions. The physical examination at the time revealed no significant findings. The roentgenogram of the wrist was interpreted as normal.

The patient returned on November 18, 1954, complaining of acute pain in the left wrist of five days' duration, which began following a round of golf. The physical examination re-

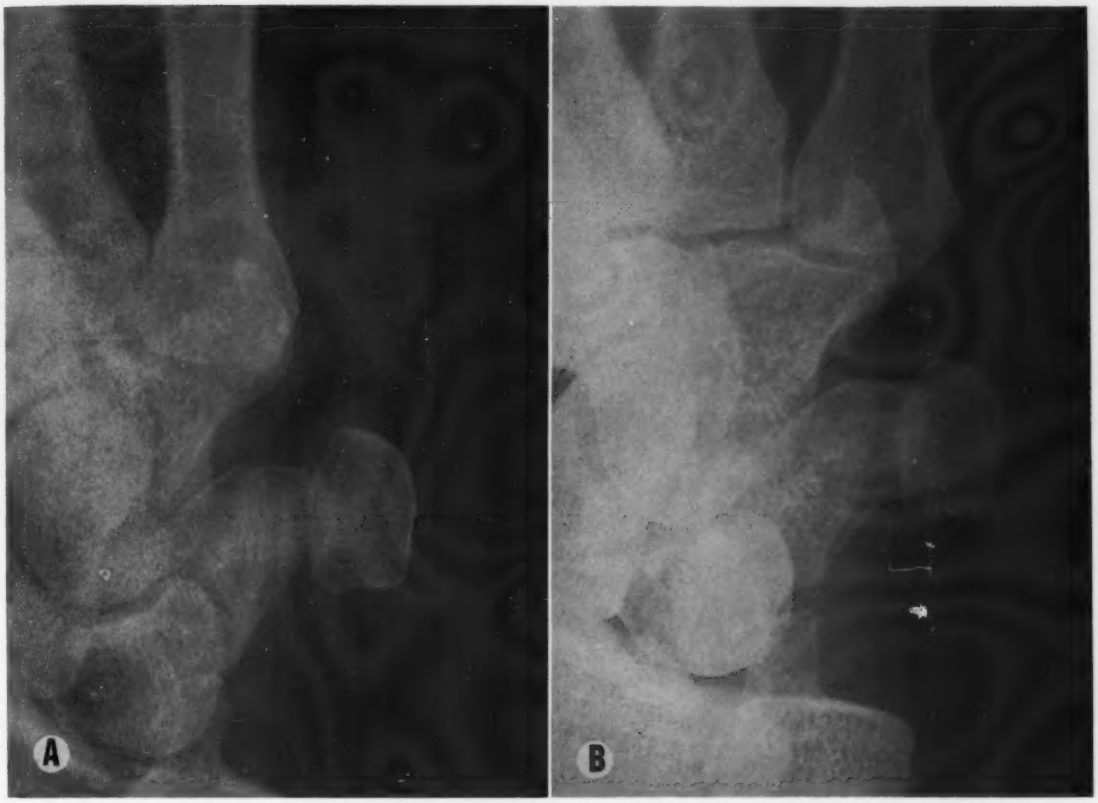

Fig. 3. Case III. (*A*) Calcification in the soft tissues adjacent to the pisiform bone with local obliteration of the fascial planes. (*B*) Roentgenogram twelve days later, demonstrating complete disappearance of the calcium deposit in the soft tissues of the wrist.

vealed a swollen, red, indurated, warm, tender area about 12 cm. in greatest dimension over the palmar aspect of the ulnar flexion of the wrist.

The roentgenogram of November 18, 1954 (Fig. 4*B*) revealed a large area of homogeneous calcium density in the soft tissues volar to the pisiform bone and slightly proximal to it. The surrounding soft tissues revealed edema and loss of the fascial planes. (A review of the previous study of June, 1951 [Fig. 4*A*] revealed that a deposit of calcium was present at this site but was somewhat smaller.)

The patient received roentgen therapy with a dose of 50 r (in air) every other day for a total of 150 r. The patient obtained marked relief of pain within 48 hours following the first treatment. One month after the completion of therapy he had occasional pain on motion and slight local tenderness. The roentgen examination at this time showed complete disappearance of the calcium deposits (Fig. 4*C*).

Acute symptoms recurred on August 2, 1955, following a round of golf. Roentgen examination at this time revealed no evidence of calcification (Fig. 4*D*). He was retreated with the same technique and there was an excellent result.

Case v. C. S., a thirty-eight year old white male pianist, had noted minor aches on motion in the left wrist for several weeks. This pain became more severe several days prior to observation. Physical examination on May 13, 1955, showed a localized discrete swelling over the greater multangular bone of the left wrist, with moderate redness, increased heat, and marked local tenderness to palpation. The pain was intensified by flexion of the fingers and especially by abduction of the thumb and flexion of the wrist.

Roentgen examination on May 13, 1955, demonstrated a large, irregular calcification adjacent the left greater multangular bone (Fig. 5*A*) and the diagnosis of peritendinitis calcarea was established.

The patient received a total of 350 r (in air)

FIG. 4. Case IV. (*A*) Roentgenogram taken June 27, 1951, demonstrating a small calcium deposit in the soft tissues anterior to the carpal bones, which was unrecognized at this time. (*B*) Roentgenogram demonstrating amorphous irregular calcium deposit in the soft tissues adjacent to the pisiform bone with obliteration of the fascial planes. (*C*) Roentgenogram following roentgen therapy demonstrating the complete disappearance of the calcium deposit in the soft tissues adjacent to the pisiform bone approximately thirty-two days after the institution of treatment. (*D*) Roentgenogram taken at the time of recurrence of the symptoms without evidence of calcium deposit in the soft tissues adjacent to the pisiform bone.

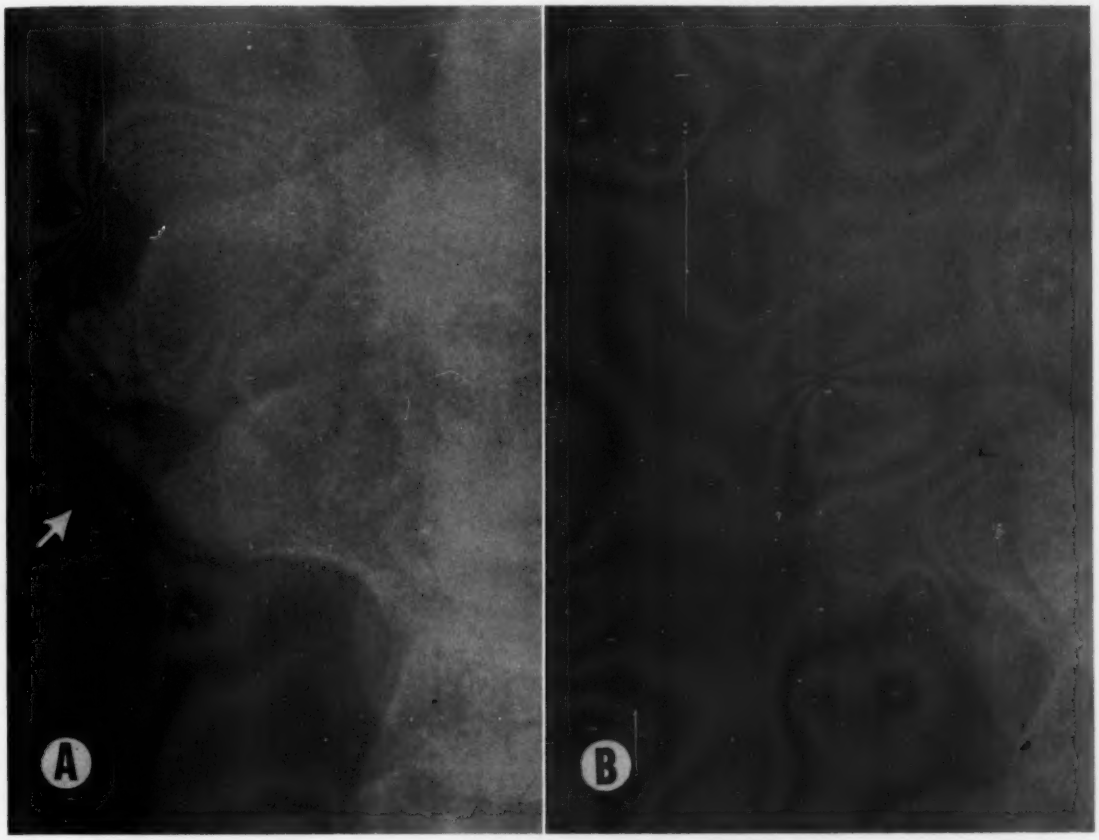

Fig. 5. Case v. (*A*) Roentgenogram demonstrating a large calcium deposit adjacent to the greater multangular bone of the left wrist. (*B*) Roentgenogram seventeen days later following roentgen therapy demonstrating almost complete disappearance of the calcium deposit in the soft tissues.

in five days, utilizing conventional 220 kv. roentgen therapy. By May 24, 1955, he was practically asymptomatic and had a gradual return to full use of the hand and wrist in one week after completion of therapy. Roentgenogram seventeen days following roentgen therapy showed almost complete disappearance of the calcium deposit (Fig. 5*B*).

Case vi. R. F., a thirty-one year old white male mechanic and stock car racer, had a two week history of "weakness" in the left wrist. Following a round of golf, he awakened in the night with intense pain and marked limitation of motion of the wrist. Examination on the following morning revealed moderate swelling of the soft tissues on the volar aspect of the lateral side of the wrist with slight redness, marked limitation of active and passive motion, and point tenderness over the greater multangular bone. The clinical diagnosis was possible fracture of a carpal bone.

The roentgen examination on August 25, 1955 (Fig. 6*A*) showed mottled amorphous calcium density in the soft tissues of the volar aspect of the wrist, at the level of the naviculo-greater multangular joint. There was edema of the soft tissues and obliteration of the fascial planes. The diagnosis of peritendinitis calcarea was made.

He was referred to the roentgen therapy division and received a total of 200 r (skin dose) in three days. He obtained complete relief of symptoms in four days following the completion of therapy and remained asymptomatic. Roentgen examination of the wrist on December 20, 1955, (Fig. 6*B*) was normal. (At this time he was treated for peritendinitis calcarea of the left shoulder and has since returned with a similar lesion in the right shoulder.)

Case vii. D. M., a thirty-five year old white female secretary, had noticed a clicking of the interphalangeal joint of the right thumb for

FIG. 6. Case VI. (*A*) Roentgenogram demonstrating mottled calcium deposit in the soft tissues of the left wrist, adjacent to the greater multangular bone. (*B*) Roentgenogram of the left wrist four months after roentgen therapy, demonstrating the complete disappearance of calcium in the soft tissues adjacent to the greater multangular bone.

FIG. 7. Case VII. (*A*) Roentgenogram of the right thumb, demonstrating small calcium deposits in the soft tissues of the dorsal aspect of the interphalangeal joint. (*B*) Roentgenogram of the right thumb seven weeks after the institution of roentgen therapy, demonstrating complete absorption of the calcium deposit.

two years. She had swelling localized to the dorsum of the thumb for six months prior to examination. There was redness and pain so severe that she was unable to hold a pencil in her hand. She was afebrile and had no history of unusual trauma.

The physical examination revealed a small firm warm nodule over the dorsolateral surface of the right thumb with some evidence suggesting fluctuation. The thunb was painful on motion.

The roentgen examination of the right thumb (Fig. 7*A*) showed punctate areas of calcification in the soft tissues posterior to the interphalangeal joint with some edema of the adjacent soft tissues. She received a total of 150 r (skin dose) in six days, with considerable relief of pain. A repeat roentgen study was obtained after three

Fig. 8. Case VIII. (*A*) Roentgenograms of the left middle finger, demonstrating amorphous calcium deposits in the soft tissues anterior to the proximal interphalangeal joint. (*B*) Roentgenograms of the left middle finger sixteen days after the completion of roentgen therapy, demonstrating a marked diminution in the extent of the calcium deposit about the proximal interphalangeal joint.

weeks and a moderate decrease in the calcium deposit was noted. Complete disappearance was found in a study seven weeks after therapy (Fig. 7*B*) and the joint was asymptomatic except for the residual click noted on motion.

CASE VIII. B. L., a forty-one year old white housewife, complained of progressive pain, swelling, redness, and stiffness in the proximal interphalangeal joint of the left middle finger of one week's duration. Physical examination revealed moderate swelling, redness, tenderness, and limitation of motion.

Roentgen examination of the finger (Fig. 8*A*) demonstrated two amorphous calcium deposits on the volar aspect of the proximal interphalangeal joint of the left middle finger, close to the bones. There was moderate soft tissue swelling with obliteration of the fascial planes.

The patient was referred for roentgen therapy and received a total of 150 r (skin dose) in six days. She obtained immediate relief of pain and a repeat roentgenogram, taken sixteen days after completion of therapy, showed the calcium deposits to be markedly diminished (Fig. 8*B*).

CASE IX. D. C., a seventy-nine year old white female, had a one year history of intermittent tenderness, pain and nodular enlargement of the proximal interphalangeal joint of the right ring finger. She developed exquisite pain, tenderness, redness, swelling and limitation of motion at this site four days prior to admission. The clinical diagnosis was acute cellulitis. The initial roentgenogram of the right hand (Fig. 9*A*) demonstrated a marked fusiform soft tissue swelling of the ring finger, with a large amorphous calcium deposit adjacent to the proximal interphalangeal joint. A smaller, more dense, but similar deposit was present adjacent to the distal interphalangeal joint. The patient received conventional roentgen therapy to the right hand between February 6, 1956 and February 14, 1956. A total of 450 r (skin dose) was given in 4 doses. Four days after the institution of therapy the patient was much improved, with less pain, swelling, and limitation of motion. The roentgen examination at this time demonstrated a considerable dissemination of the large calcium deposit which then

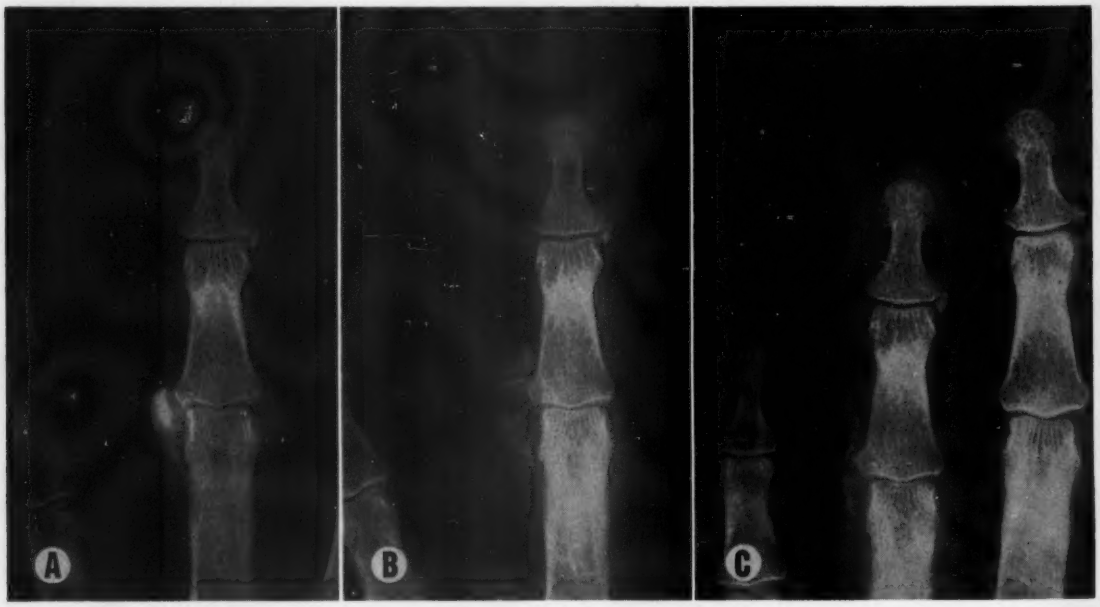

FIG. 9. Case IX. (*A*) Roentgenogram of the right ring finger, demonstrating a large amorphous calcium deposit lateral and adjacent to the proximal interphalangeal joint of the ring finger. A smaller dense calcium deposit is noted adjacent to the distal interphalangeal joint. (*B*) Roentgenogram made four days after the institution of roentgen therapy, demonstrating some dissemination of the calcium deposit adjacent to the proximal interphalangeal joint, but a marked decrease in the density throughout. The soft tissue swelling persists. (*C*) Roentgenogram made twenty-two days after the initiation of roentgen therapy, demonstrating a marked decrease in the size and extent of the calcium deposit adjacent to the proximal interphalangeal joint. The calcium deposit adjacent to the distal interphalangeal joint remains unchanged.

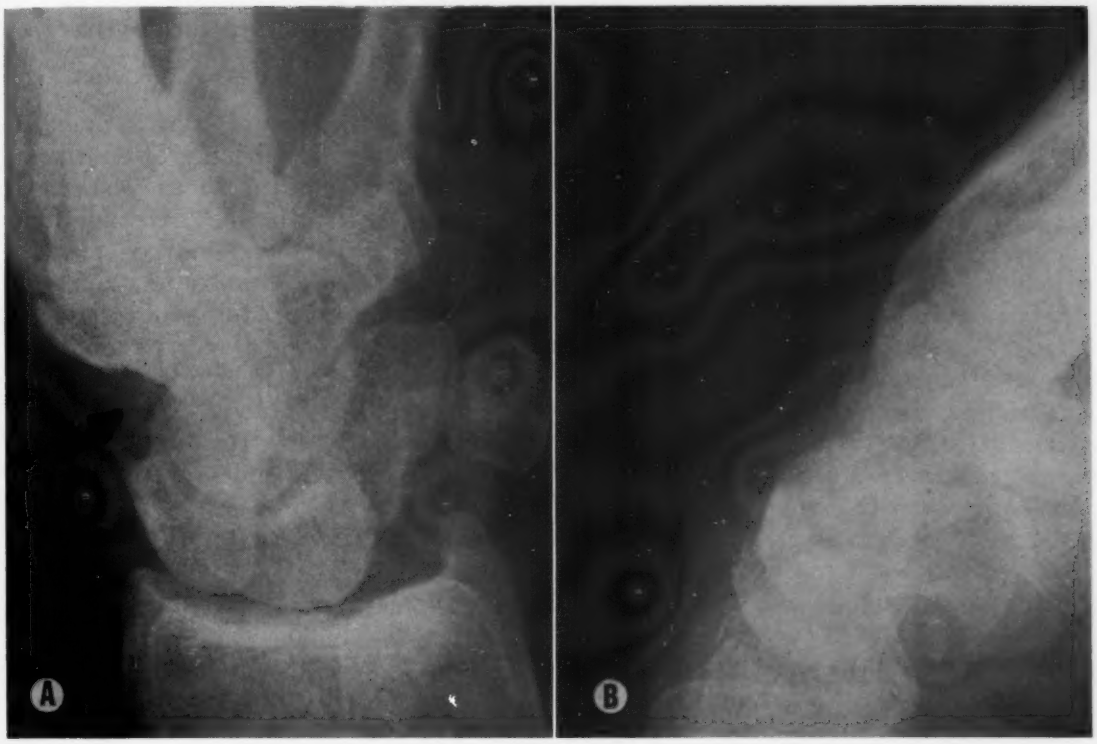

Fig. 10. Case x. (*A*) Roentgenogram of the left wrist, demonstrating a small calcium deposit in the soft tissues adjacent to the dorsal aspect of the capitate bone. There is rather marked soft tissue swelling and obliteration of the fascial planes. (*B*) Roentgenogram made three days after the institution of roentgen therapy, demonstrating the wrist to be normal in appearance.

occupied a larger area but was less dense in appearance (Fig. 9*B*).

Progress was quite satisfactory following therapy. The final roentgenogram on February 28, 1956, revealed almost complete resolution of the calcification adjacent to the proximal interphalangeal joint (Fig. 9*C*). Normal function was restored.

Case x. S. L., a fifty-seven year old white female, was seen in the Emergency Room because of extreme pain, redness, swelling, limitation of motion, and point tenderness over the dorsum of the left wrist for the previous 24 hours. Routine roentgenograms of the wrist showed soft tissue swelling over the dorsum. A lateral view made in flexion demonstrated an amorphous calcium deposit in the soft tissues over the dorsal aspect of the capitate bone (Fig. 10*A*). The orthopedic resident injected the area with hydrocortone and novocain, whereupon immediate relief was obtained.

The patient was referred for roentgen therapy the following afternoon at which time most of the signs and symptoms had recurred, and were only slightly less severe. The patient received a total of 250 r (skin dose) in four days, directed to the dorsum of the hand. She was asymptomatic when she returned for the second treatment, but had some residual point tenderness.

The wrist was completely normal in appearance at the conclusion of therapy (Fig. 10*B*). The patient was asymptomatic and a full range of motion was restored.

DISCUSSION

There was a rather constant clinical picture. Most patients gave a history of a recent acute episode usually of one to three days' duration. In some this episode was superimposed or associated with the subacute or chronic variety with annoying transient symptoms of several weeks' duration, the longest being three and one-half years. Trauma appeared to aggravate this variety and in several cases, a game of golf

or other exercise immediately preceded the onset of the acute symptoms. Recurrence occurred in one instance.

The patients were treated with deep roentgen therapy (220 kv., 15 ma., half-value layer 1.3 mm. Cu, target skin distance 50 cm.). Treatment was directed to the involved site, and the field was of sufficient size to include all areas of redness. The dose varied from 50 to 150 r (skin dose), usually administered every other day for a period of five to eight days, until a total dose of 450 r was reached.

The radiation therapy was effective in all cases. The response was immediate in the acute form with marked relief of pain in 24 to 48 hours, rapid regression of the redness and soft tissue swelling, and restoration of full function in four to seven days. The chronic form exhibited a more prolonged response with relief of pain in four to seven days after therapy and restoration of function in one to two weeks. In general, the response was related to the degree of acuteness of the process and to the extent of the surrounding soft tissue swelling and redness. These results compare very favorably with reports of those treated by other modes of therapy, in which one to three weeks is required for relief of the acute symptoms and longer periods in the more chronic case.[1–4,9,10,15]

The roentgenograms demonstrated an immediate change in the character of the calcium deposit following the institution of radiation therapy. This was most vividly shown in Case IX, where serial film studies were obtained at frequent intervals. Complete disappearance occurred in almost all cases.

CONCLUSIONS

Peritendinitis calcarea of the hand and wrist is believed to be a self-limited disease with a low incidence of recurrence and one which is prone to remission. It is characterized by typical clinical and roentgenographic findings. Immobilization, incision and drainage, aspiration, novocain injection, hydrocortone injection, analgesics, vitamin E, and roentgen therapy have all been used with some degree of success in its treatment.

Our experience indicates that roentgen therapy is an excellent mode of treatment, particularly in the acute form of the disease. We feel it to be the preferable form of therapy, for it gives marked relief of symptoms and restoration of function more rapidly than do other forms of treatment. Furthermore, roentgen therapy does not entail the risk of introduction of infection or damage to the involved tissues of the hand, associated with the various surgical procedures, and is painless in its administration.

SUMMARY

The problem of peritendinitis calcarea about the hand and wrist is reviewed, and 10 cases are presented which were successfully treated with roentgen therapy.

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The authors wish to thank Dr. F. Forsyth and Dr. C. Young, Jr., of the Department of Orthopedics of the Bowman Gray School of Medicine, for their permission to use the cases reported.

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CORACOCLAVICULAR JOINT*

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THE coracoclavicular joint is a rare congenital anomaly which may be the underlying cause of a painful shoulder. The joint occurs at the junction of a bony projection extending inferiorly from the outer third of the clavicle at the site of the conoid tubercle and a bony projection extending superiorly from the coracoid process of the scapula. Slocum[10] believes this to be a true diarthrodial joint with a cartilage covered articular surface and joint capsule. He believes the etiology to be a congenital variation as suggested by Gowland rather than a traumatic sequela as postulated by Lane.

INCIDENCE

Most authors feel that the coracoclavicular joint is rare. Wertheimer,[11] found 2 in 277 roentgenograms, Gruber found 1 in 38 cases, Pondé and Silviera[7] 1 in 2,300 roentgenograms, Schlyvitch[9] 1 in 60 cadavers and Frassetto and Testut each reported 1 case.

The rarity of this finding is contested by Nutter[6] who found 12 joints in 1,000 roentgenograms and Poirier who found 3 in 10 cadavers.

We have reviewed 3,886 chest roentgenograms, some taken as part of a routine admission program at St. Francis Hospital and others taken at the Pearl Harbor Naval Base. Only those roentgenograms where both shoulders could be clearly seen were included. Many prominent conoid processes of the clavicle were seen; however, unless definite opposing surfaces were visualized, the roentgenogram was excluded from the category of a definite or probable coracoclavicular joint. Of the 3,886 cases reviewed, there were only 5 cases of what we considered definite coracoclavicular joints plus 2 cases of what probably were coracoclavicular joints. In the latter cases for various reasons, the persons could not be rechecked by a larger or better roentgenogram; however, the findings on the small film would justify grouping these with the first 5. Of the cases of definite coracoclavicular joints, there were 2 cases in which the anomaly was bilateral and in 3 cases it was unilateral. These findings confirm those of other authors who have concluded that this anomaly is extremely rare.

CLINICAL SIGNIFICANCE

That the coracoclavicular articulation may exist without symptoms is obvious from the fact that it is usually an incidental finding. According to Frassetto,[3] the articulation is a predisposing factor in fractures of the surgical neck of the humerus. Possati[8] presents a case of a sixty-three year old man who complained of pain in his shoulder and limitation of motion. Roentgenograms revealed osteoarthritis involving a coracoclavicular joint.

Del Valle and Giordano[2] observed a woman, aged thirty-five with a painful cervicobrachial syndrome which improved after resection of the coracoclavicular joint. One of Wertheimer's[11] 2 cases was a thirty-seven year old male Negro who had had pain in his shoulder for three years. This pain was relieved by resection of the coracoclavicular joint. In Hall's[5] case, there was no pain but there was limitation of abduction. This also was relieved by resection of the coracoclavicular joint.

Our interest in this subject was originally stimulated by a patient of Dr. John W. Cooper,[1] the fourth case of coracoclavicular joint to be operated upon. A more detailed presentation of this case will be reported by him, but briefly it was that of a nineteen year old male who had had pain in his left shoulder for one and one-half years prior to his admission to St. Francis Hospital. This pain was aggravated by motion and par-

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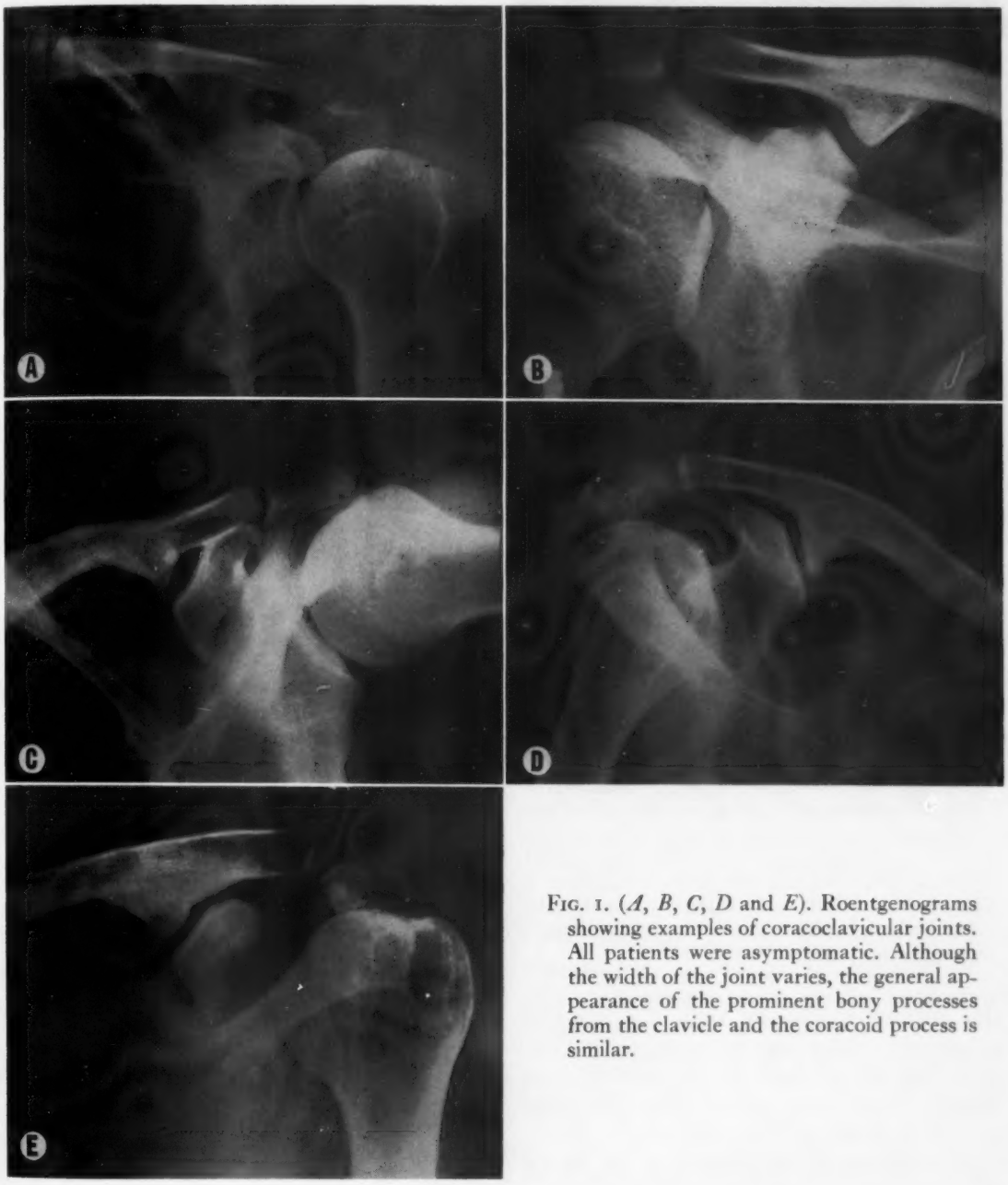

Fig. 1. (*A*, *B*, *C*, *D* and *E*). Roentgenograms showing examples of coracoclavicular joints. All patients were asymptomatic. Although the width of the joint varies, the general appearance of the prominent bony processes from the clavicle and the coracoid process is similar.

ticularly by raising the arm above the head. Following resection of a coracoclavicular joint (Fig. 2), the symptoms were relieved.

The significance to the radiologist would seem to be an awareness of such an anomaly and the possibility that it may be the cause of a painful shoulder syndrome. The actual proof of a true diarthrodial joint is necessarily difficult to establish by routine roentgenography. Nutter[6] states, "Although all of these separate anatomical structures cannot be demonstrated by ordinary roentgenographic methods, the presence of a large clavicular bony process, which has a facet that conforms to the adjacent end of the coracoid, appears to be as adaptable to

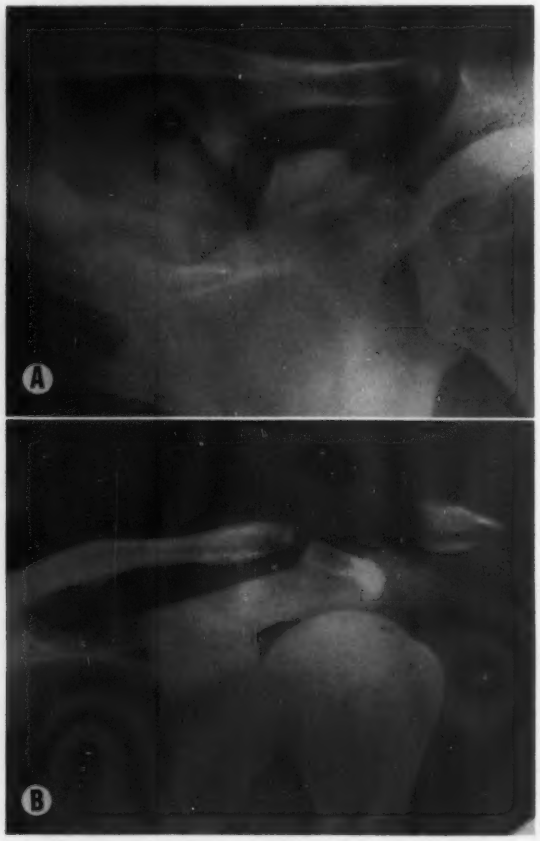

FIG. 2. (*A*) Left shoulder of C.M., a nineteen year old male who complained of pain for one and one-half years. A similar joint was present on the right but was asymptomatic. (*B*) Roentgenogram of left shoulder following resection of the coracoclavicular joint which can be seen adjacent to the shoulder. The patient has since been free of symptoms, a period of one year.

this surface as the surfaces of other true joints are adaptable to each other, and with the coracoid forms an interarticular space, leaves little doubt that the other joint structures are also present."

Wertheimer states that it is not necessary to infer a true diarthrodial joint, as the significant finding is the presence of opposing bony surfaces, not the fact that a true diarthrodial joint exists. Schlyvitch, in examining the shoulders of 60 cadavers, found that in 8 there was opposing bony contact. Six of these had cartilage lining, but of these 6, only 1 had all the elements of a true diarthrosis. The presence of opposing bony surfaces is significant in that a painful shoulder syndrome may, in time, result.

SUMMARY

The coracoclavicular joint, a rare anomaly which may be the cause of pain in the shoulder, is discussed. A case is reported in which pain was relieved by the resection of the joint. Its rarity is proved by the fact that during a review of 3,886 roentgenograms it was discovered only 5 times.

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We are indebted to Dr. Ralph B. Cloward for making the illustrations. A description of his technique for the preparation of roentgenographic reproductions is to be published.

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FOUR NORMAL ANATOMIC VARIATIONS OF IMPORTANCE TO RADIOLOGISTS*

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THE mark of the experienced radiologist is often his ability to recognize a wide range of variation of normal anatomy. An appreciation of the nature of these differences is important in his every day work in obviating errors of commission as well as of omission.

This paper proposes to describe four anatomic variations, in the occipital bone, in the sternum, in the calcaneus, and in the heart, which have presented problems in diagnosis and which, if unrecognized, may lead to unnecessary investigative procedures. A review of the literature has revealed no detailed description of these particular normal entities.

LARGE OCCIPITAL DIPLOIC VENOUS LAKES

The commonly seen diploic venous lakes of the cranium usually present no difficulties in identification; they are small and frequently show continuity with vascular impressions in the skull. They are most likely to be found in the frontal and parietal bones and occasionally in the occipital bone. Not uncommonly, however, the occipital bone may show venous lakes which may be so extensive as to suggest a pathologic state (Fig. 1 and 2). These vascular diploic spaces may be scattered throughout the bone or may be confluent and may or may not be symmetrically distributed about the midline. Occipital venous lakes may vary considerably in size and configuration (Fig. 3) and are most commonly seen in patients past the age of fifty. Apparently the enlargement of these vascular spaces is a part of the aging process.

In cases where there are symptoms referable to the skull and where the size of the occipital venous lakes is marked, these vascular spaces may be confused with various benign tumors of the skull such as angiomas or intradiploic epidermoids.

Small similar lesions have been illustrated by other authors and have been designated as vascular spaces.[3,4] Lindblom[2] has suggested that widened occipital diploic spaces may be seen in patients with intracranial neoplasms and arteriovenous aneurysms. However, it would appear that such enlargement can occur without association with such lesions in older patients. In our own experience, the frequency of this finding, the absence of pertinent signs and symptoms, and follow-up examinations have assured the benignancy of these lesions. The experience of neurosurgeons at this institution in encountering similar lesions at surgery has confirmed their vascular nature.

VARIATION IN CONFIGURATION OF THE XIPHOID PROCESS AND CALCIFIED COSTAL CARTILAGE SIMULATING DESTRUCTIVE LESIONS OF THE STERNUM

The roentgen appearance of the xiphoid process and calcified costal cartilage is subject to considerable variation, depending largely upon the extent of calcification and the prominence of the costosternal articulations. Ordinarily, these variations are not of importance. However, occasionally the roentgen images of the calcified costal cartilages and the sternum in the lateral projection may fall into a pattern which simulates a destructive lesion of the xiphoid process and adjacent portion of the body of the sternum. This is particularly a problem in patients with symptoms referable to the sternum. Figure 4 illustrates this situation. The patient, a forty-six year old

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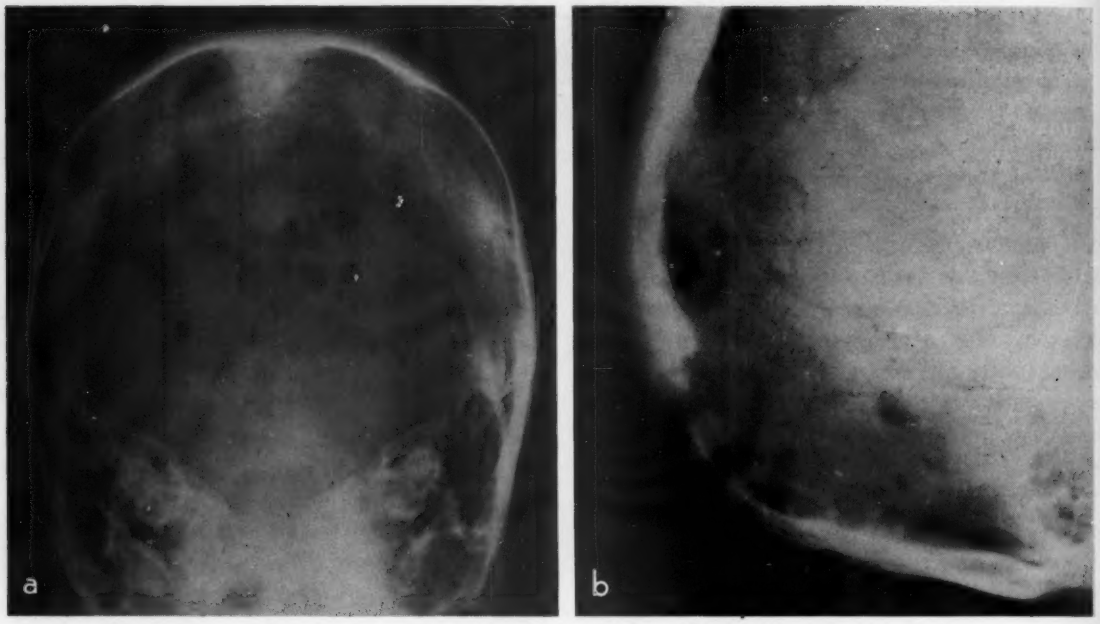

Fig. 1. (*a*) Anteroposterior and (*b*) lateral roentgenogram of the occipital bone of a seventy-one year old female showing large occipital venous lakes originally interpreted as representing cystic lesions.

male, complained of pain and swelling of the lower half of the sternum. The lateral roentgenogram of the sternum was interpreted as showing a cystic destructive lesion of the xiphoid process and body of the sternum. Surgery was performed and no abnormality was found.

Fig. 2. Roentgenogram of the occipital bone of a sixty-eight year old male with cerebral arteriosclerosis showing large occipital venous lakes.

This misleading appearance is a combination of a curved xiphoid process with convexity directed posteriorly, concavity of the caudal end of the body of the sternum, plus heavy costal cartilage calcification seen anteriorly. This variation in appearance is not unusual. Figure 5 demonstrates a similar configuration in a normal patient. The importance of recognizing this finding as normal variation is obvious.

SIMULATION OF FRACTURE OF THE CALCANEAL TUBEROSITY BY THE APOPHYSIS IN THE OBLIQUE PROJECTION OF THE FOOT

In roentgenographically examining the feet of young people for fracture, we have encountered, on several occasions, in the oblique projection of the foot a small flake-like portion of bone apparently lying in the soft tissues of the plantar aspect of the heel with irregularity of the underlying calcaneal tuberosity (Fig. 6). This finding

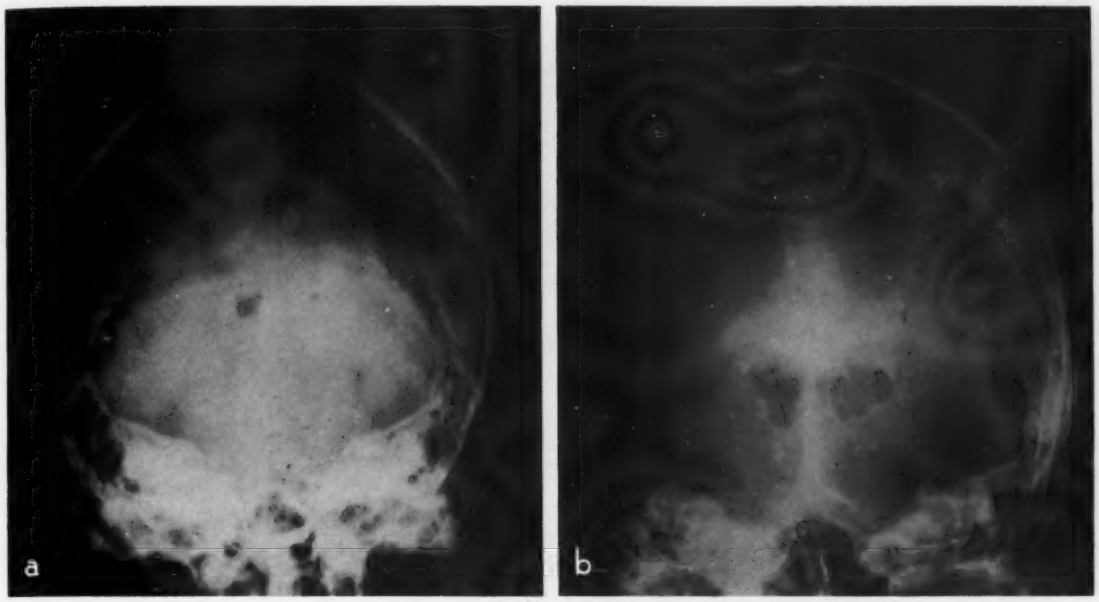

FIG. 3. (*a* and *b*) Roentgenograms of the occipital bone of 2 patients without intracranial disease showing variation in size and shape of venous lakes.

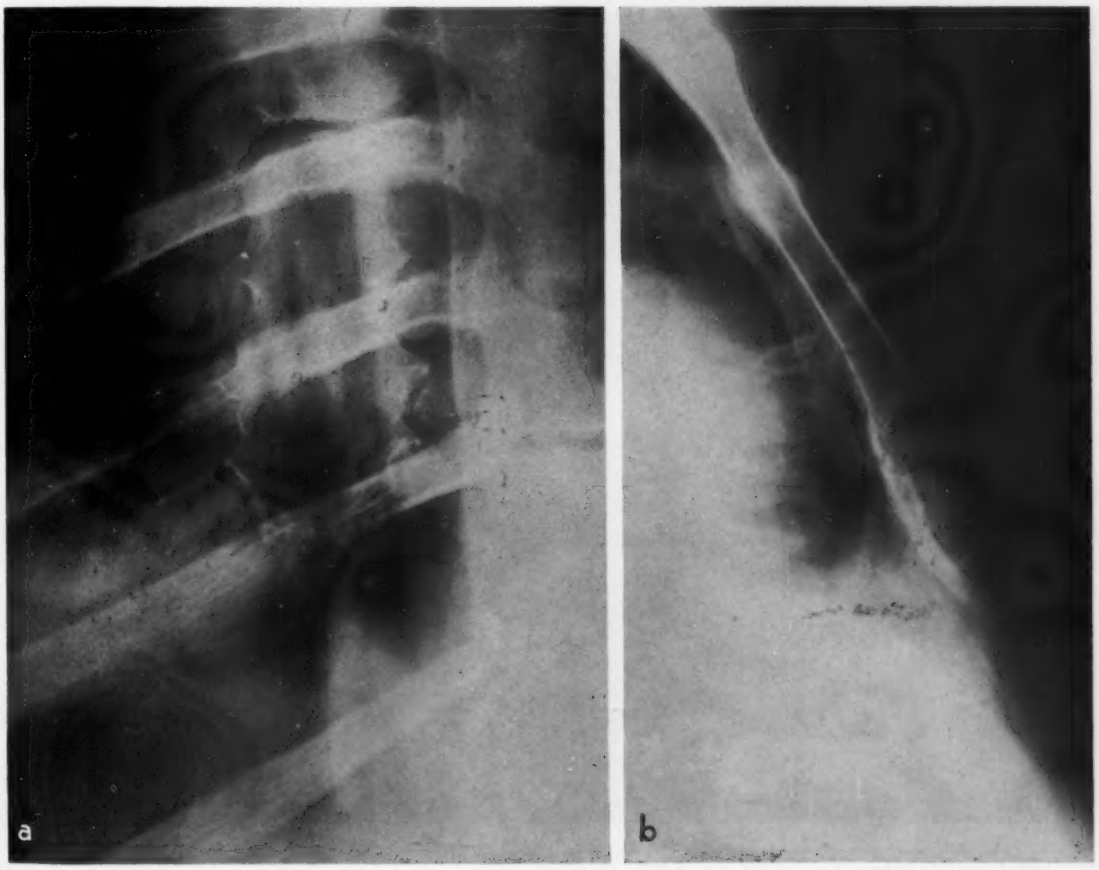

FIG. 4. (*a*) Posteroanterior and (*b*) lateral roentgenogram of the sternum in a forty-six year old male with symptoms referable to the lower sternum. In lateral projection a destructive lesion of the distal sternum is simulated.

FIG. 5. Lateral roentgenogram of the sternum in a normal patient showing appearance similar to that of Figure 4.

was originally misdiagnosed as a fracture, in spite of the absence of symptoms in this area, since a similar appearance was not demonstrated in the other foot.

Since this incident we have encountered an identical appearance in other patients, again without signs of symptoms referable to the calcaneus (Fig. 7). In each case the calcaneal apophysis was still open. The simulated fracture is produced by projection of the caudal tip of the apophysis into the soft tissues of the heel in the oblique view. The suggestion of fracture is further strengthened by the normal irregularity or even slight concavity of the adjacent bone of the calcaneal tuberosity. Apparently variations in prominence of this tip of the calcaneal apophysis result in the inconsistent appearance of this finding for it may be demonstrable only unilaterally in a given patient.

ROENTGEN VISUALIZATION OF THE PERICARDIAL SHADOW OF THE RIGHT CARDIAC BORDER

Kremens[1] in a recent publication has described visualization of the normal pericardial shadow made evident by the relatively radiolucent subepicardial fat along the left heart border in routine postero-anterior roentgenograms. He has pointed out that the pericardium is not visualized in any of the cardiac contours other than along the left border in this projection. This has not been confirmed in our experience. Occasionally we have visualized shadows, identical to those which he describes, along the right cardiac border in patients without heart disease (Fig. 8).

This finding is of significance only in

FIG. 6. (*a*) Oblique roentgenogram of the right foot in a nine year old female showing a portion of bone in soft tissues of the heel with irregularity of the underlying calcaneal tuberosity suggesting chip fracture. (*b*) Oblique roentgenogram of the left foot in same patient showing absence of the appearance shown in *a*. (*c*) Lateral roentgenogram of right foot in same patient showing open calcaneal apophysis.

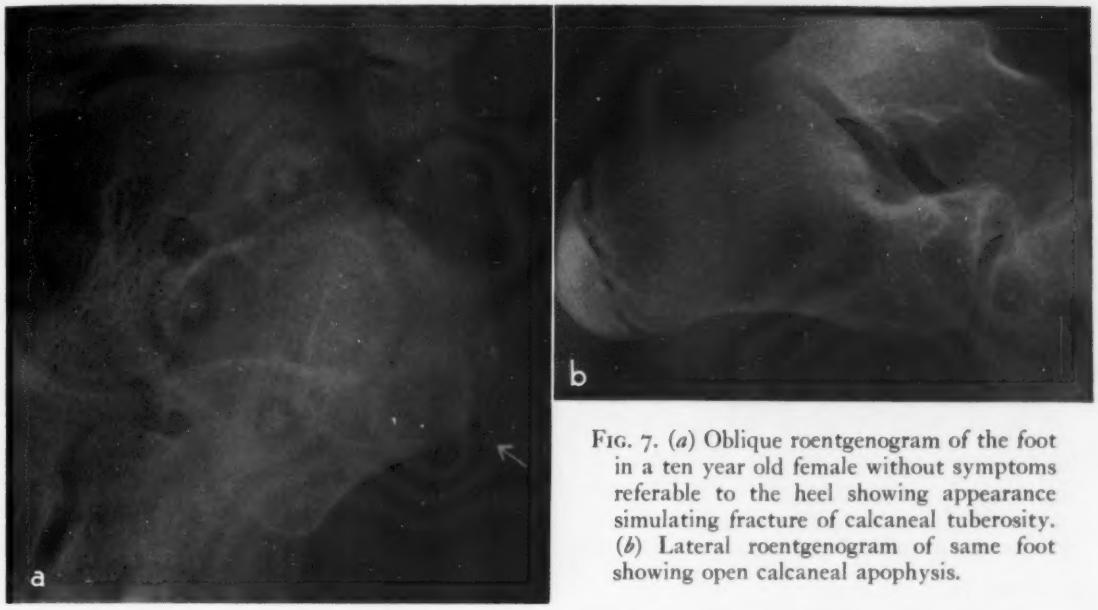

Fig. 7. (*a*) Oblique roentgenogram of the foot in a ten year old female without symptoms referable to the heel showing appearance simulating fracture of calcaneal tuberosity. (*b*) Lateral roentgenogram of same foot showing open calcaneal apophysis.

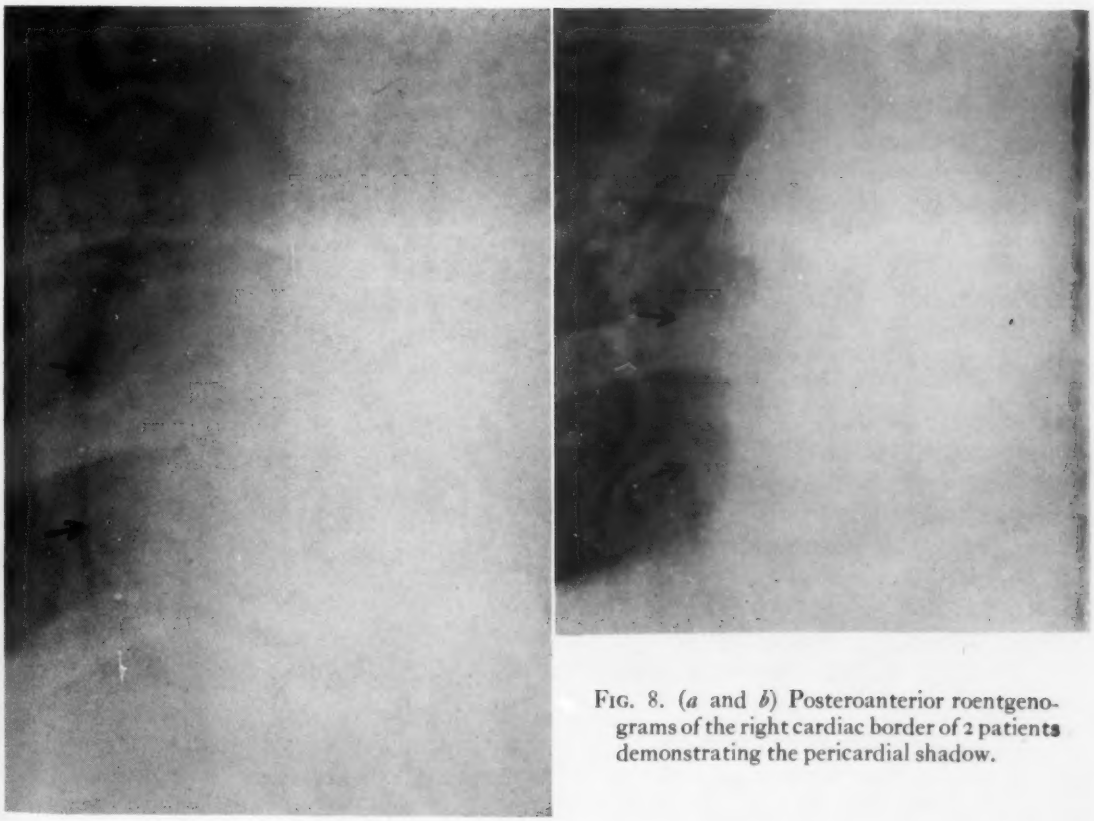

Fig. 8. (*a* and *b*) Posteroanterior roentgenograms of the right cardiac border of 2 patients demonstrating the pericardial shadow.

that the pericardial shadow may be sufficiently striking to simulate calcification and has been misinterpreted as pericardial or myocardial calcification. As suggested by Kremens, this appearance is probably the result of contrast with the adjacent radiolucency of the subepicardial fat. It is a readily observable roentgen phenomenon that certain structures will demonstrate an apparent radiopacity which is greater than is actually the case because of contrast with adjacent shadows of relative radiolucency. Apparently this occurs in visualization of the pericardial shadow.

In those cases in which the pericardium has been visualized, failure to reproduce this shadow consistently in several roentgenograms, or with slight changes of position of the patient will indicate the true nature of this shadow.

SUMMARY

Four normal anatomic variations of importance to radiologists have been described. These are large diploic venous lakes of the occipital bone, variation in roentgen appearance of the caudal end of the sternum which may simulate a destructive lesion, simulation of fracture of the calcaneal tuberosity by the apophysis in the oblique projection of the foot, and roentgen visualization of the pericardial shadow of the right cardiac border. The importance of these variations lies in distinguishing them, roentgenologically, from pathologic lesions.

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Addendum

Since this paper was submitted for publication, the author encountered an illustration on page 716 of the 1956 edition of "Pediatric X-ray Diagnosis" by John Caffey demonstrating an appearance of the calcaneus similar to that described in this report. He attributed this to a secondary ossification center in the tip of the trochlear process of the calcaneus.

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CHOROID PLEXUS CALCIFICATION IN AN UNUSUAL LOCATION AND MOBILE*

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ABNORMAL calcification in the cranium and displacement of intracranial structures are important findings for the diagnosis and localization of intracranial lesions. Correct evaluation of the significance of calcification in the choroid plexus of the lateral ventricles may be difficult when it is present in early childhood or is unilateral, and when it is in an unusual location. The purpose of this paper is to present pertinent material, and to report a case in which choroid plexus calcifications are in an unusual location and are mobile. A similar report was not found in the literature.

ANATOMY

The choroid plexus of each lateral ventricle is a vascular process of pia mater, which protrudes into the ventricular cavity. They join at the interventricular foramen and extend to the end of each temporal cornu. The glomus choroideum is an enlargement of each plexus situated at about the junction of the inferior and posterior horn with the body of the lateral ventricle. Calcium deposits in the choroid plexuses are usually located in the glomera.[2] They are generally fairly symmetrically situated on each side of the median plane, and posterior and superior to the pineal shadow in lateral skull roentgenograms. The calcification on the side farthest from the film is usually projected slightly behind and above the nearer one in lateral views.

CALCIFICATION

The choroid plexus is a favorite site for regressive changes.[5] These include formation of cysts and psammomata. The density of the calcifications is related to the degree of calcification of the psammoma bodies.[3] The calcific deposits vary from minute shadows to more than 1 cm. in diameter. The amount and density of the calcifications are usually fairly symmetrical, but they may be different on each side. They are usually irregular, round or kidney shaped. Calcification may occasionally occur in parts of the plexus other than the glomus. The most frequent of these sites is in the area between the glomus and the foramen of Monro.[7] Their shape tends to be linear when they are located outside the glomera.[8]

Choroid plexus calcification is about twice as frequent in males as in females. It does not ordinarily occur before about the age of ten years,[4] and the incidence increases with age. There are rare exceptions to the age at which they appear. Calcification in one glomus in a five year old child and in the one on the opposite side two years later has been reported.[10]

These calcifications are generally not considered clinically significant. Healed congenital toxoplasmosis has been suggested as the etiology in some children.

DISPLACEMENT

Change in the position of the glomera may be due to their mobility,[6] to atrophy or to hypoplasia of the cerebral hemispheres,[11] and to space occupying lesions,[1,5] Little or no displacement may occur when a space occupying lesion is far anterior in the frontal or temporal lobes. The firm support by the falx is apparently chiefly responsible for this.[8]

REPORT OF A CASE

The following case is unique in that the calcification in each choroid plexus is large,

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FIG. 1. The calcifications (arrows) in the choroid plexuses are lateral and caudad to the location of the glomera. Stippled areas indicate the usual position of these calcifications.

FIG. 2. Anteroposterior roentgenogram in recumbent position shows that the calcifications are more cephalad and mesial than in Figure 1. The change in position on the right side (double arrows) is marked.

kidney shaped, mobile, and located in a part of the plexus other than the glomus.

A thirty-eight year old white male was admitted to the hospital June 28, 1955, complaining of dyspnea on exertion, epigastric pain, and insomnia. The past history was irrelevant. Physical and neurologic examinations were negative. Routine and special laboratory tests were normal. Roentgen examinations of the chest and gastrointestinal tract were negative. An electrocardiogram and an electroencephalogram were normal.

Symmetrical intracranial calcifications were noted in roentgenograms of the nasal accessory sinuses. The sinuses appeared normal. Roentgen examination of the skull in the posteroanterior recumbent position (Fig. 1) showed that these calcifications were lateral and much caudad to the location of the glomera. Their position corresponded to that of the anterior part or end of each temporal horn. The calcifications, in the anterior recumbent position (Fig. 2), were in a more cephalad and mesial position. The change in location was most marked on the right side. Examination in the right lateral recumbent position (Fig. 3) showed that the calcific deposits were in the anterior temporal horn area. With the head in the right lateral

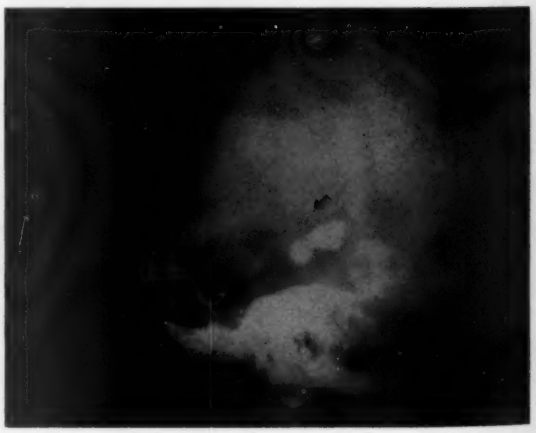

FIG. 3. Right lateral roentgenogram in recumbent position. The calcifications are in the posterior temporal horn areas. Note their position in relation to the calcification (arrow) of the pineal gland.

Fig. 4. Right lateral roentgenogram in supine position with the neck extended. The calcification on the right side (double arrows) is in a more cephalad position, and the left one is in the posterior part of the left temporal horn area. Calcification (single arrow) of the pineal gland.

supine position and the neck extended (Fig. 4), the calcification on the right side occupied a position which corresponded to the region of the posterior part of the body of the corresponding lateral ventricle. The one on the left side was in the posterior part of the left temporal horn region. Roentgenograms of the skull in the posteroanterior Trendelenburg, posteroanterior erect, and in the right lateral erect position also showed change in the location of the calcifications.

The position of the calcifications (Fig. 1), the directions in which they move, and the return to their original location indicate that they are in the part of the choroid plexus situated far anterior in each temporal horn. Each calcification is apparently attached by a pedicle of different length.

The patient improved under symptomatic treatment, He was last seen about ten months after admission to the hospital. There were no new developments. Re-examination of the skull showed that the calcifications in the choroid plexuses were in the same location and moved in the same directions as in the original examination.

SUMMARY AND CONCLUSIONS

Abnormal intracranial calcification and unusual position of structures within the cranium are important findings for the diagnosis of intracranial lesions.

The normal roentgen anatomy, position, variants, etiology, and significance of calcification in the choroid plexus of the lateral ventricles are presented.

A case is reported in which extensive bilateral kidney shaped choroid plexus calcifications are present in the part of the plexus situated far anterior in the temporal horn of each lateral ventricle instead of in the glomera. They are apparently attached by pedicles because they change position under the influence of gravitation, and they return to their original symmetrical location in the end of each temporal horn.

The history, neurologic examinations, roentgen studies of the skull, normal position of the pineal gland, free mobility of the calcifications in contradistinction to displacement and follow-up roentgen examination which did not show any change from the original observation exclude the presence of an intracranial lesion.

The calcifications described are considered normal variants. A report of a similar case was not found.

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RIGHT-SIDED DIAPHRAGMATIC LIVER HERNIA FOLLOWING TRAUMA

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RIGHT-SIDED traumatic diaphragmatic herniation of the liver has been recorded infrequently in the medical literature, while the more common left-sided traumatic hernia, which seldom includes the liver, has understandably received greater attention. This discovery of 4 additional traumatic liver hernias on the right side has prompted the present report and a review of 19 similar cases previously described in the literature.

As is well known the diaphragm is not infrequently the site of herniation. These hernias are commonly classified as congenital and acquired with the latter being subdivided into traumatic and nontraumatic. Congenital and acquired nontraumatic hernias occur most commonly at the esophageal hiatus and at points of failure of embryonic fusion, while traumatic hernias occur anywhere in the diaphragm. Diaphragmatic hernias as a group have been well described elsewhere,[8,9] and only the rare right-sided traumatic hernia, which includes all or part of the liver, will be considered here.

The traumatic hernia, as its name implies, is associated with specific trauma which may be due to a direct penetrating injury to the diaphragm or may be secondary to a blunt external force applied to the thorax or abdomen. Traumatic diaphragmatic hernia is not common, only 13 per cent of Harrington's 524 cases being so classified,[8] and is particularly rare on the right side. Hedblom[9] placed the relative incidence of left over right-sided traumatic hernia at 19 to 1, and only 2 of Harrington's 72 traumatic diaphragmatic cases were on the right. Right-sided traumatic diaphragmatic hernia is seen less commonly because of the protection offered to the diaphragm by the large mass of liver beneath it.

Traumatic herniation of the liver through the right hemidiaphragm can be divided into three types. Type I is represented by those cases with isolated total herniation of the liver; Type II consists of isolated herniation of a part of the liver; Type III includes those cases with herniation of other elements of the gastrointestinal system in addition to the liver. It should be noted that all reported examples of herinated liver through the left hemidiaphragm were similar to Type III in that the stomach, colon, or other abdominal structures protruded into the thorax.[9]

REPORT OF CASES

Case I. #81681, sixty year old male. The patient was admitted to Cincinnati General Hospital following an auto accident in December, 1949. He was comatose and had suffered multiple fractures including a depressed right parietal skull fracture and several fractured ribs on the right side. A portable anteroposterior chest roentgenogram (Fig. 1) revealed a dome-shaped shadow simulating an elevated right

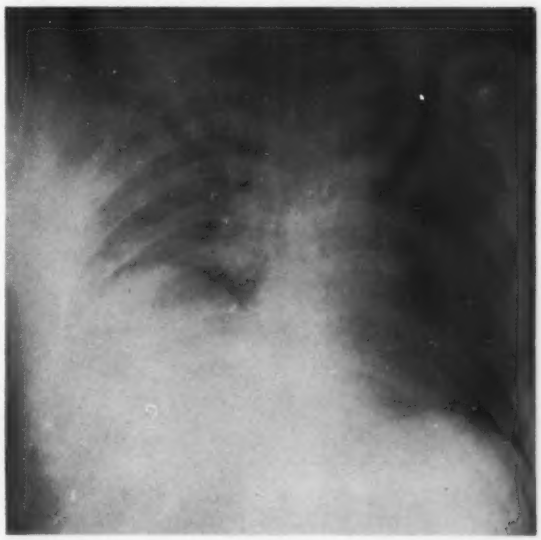

Fig. 1. Case I. Complete traumatic liver herniation (Type I). Note the high arcuate shadow in the lower right hemithorax. The elevated inferior liver margin is not well shown in the reproduction.

diaphragm. This was interpreted as a possible traumatic liver hernia. The patient never regained consciousness, despite elevation of the skull fracture, and died 72 hours after admission. At necropsy, he was found to have a tear across the posterior leaf of the right hemidiaphragm extending to within 5 cm. of the anterior costal attachment. The liver extended through this defect and lay almost entirely in the thoracic cavity.

Comment. This case represents the picture seen in large diaphragmatic defects with the rarest type liver hernia (Type 1). The patient's condition did not allow further diagnostic efforts to explain the abnormal density in the right thorax. The liver was found rotated anteriorly and superiorly as is usually the case in complete liver herniation.

Case II. #15994, sixty year old white male. This victim of an auto accident was admitted to Cincinnati General Hospital in December, 1950. Examination revealed fractures of the left tibia, fibula and ulna. There was slight cyanosis and grunting respiration. There was also noted right upper quadrant rigidity and elevation of the level of liver dullness to percussion. The anteroposterior recumbent chest roentgenogram (Fig. 2) was interpreted as a possible liver hernia or eventration of the right hemidiaphragm. Chest fluoroscopy was reported as follows: "Fluoroscopy of the diaphragm shows the left hemidiaphragm to be normal. On the right there is minimal respiratory motion of the dome-shaped shadow which extends superiorly to the seventh interspace. This movement is no more, however, than would be expected with the change in intra-abdominal pressure. The mass apparently extends from the ventral to the dorsal surface of the lower right thoracic cavity. Just lateral to the right heart border a short horizontal linear shadow is seen. This is felt to represent the torn medial leaf of the right hemidiaphragm, as it moves equally as well as the corresponding portion of the opposite diaphragm." Impression: "Herniation of the liver into the right thorax."

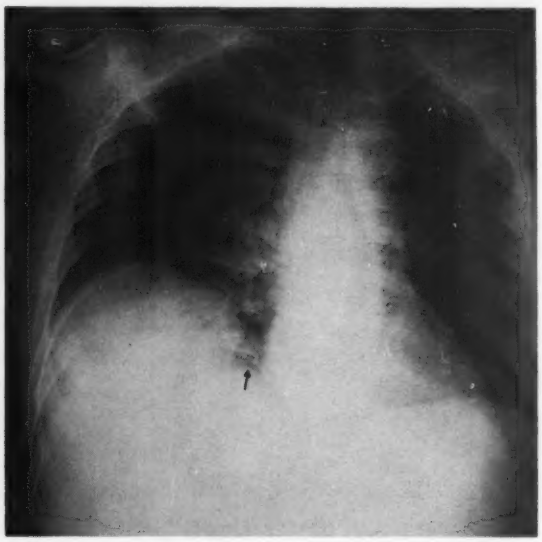

Fig. 2. Case II. Complete liver herniation, Type 1. Fluoroscopy showed respiratory motion of the medial leaf of the torn right hemidiaphragm (arrow). Proved at operation.

The above impression was confirmed at operation where a diaphragmatic tear was found extending from the anterior axillary line transversely across the posterior portion of the right hemidiaphragm almost to the vena caval opening. The entire liver lay in the chest. The liver was successfully reduced and the diaphragmatic tear closed without difficulty.

Comment. In this case the characteristics of isolated massive liver herniation (Type 1) are again demonstrated. It is one of the few such cases diagnosed prior to operation, and is probably the only case diagnosed solely by means of a chest film and fluoroscopy.

Case III. Twenty-seven year old colored male. This patient was admitted to St. Mary's Hospital, Cincinnati, in July, 1951 following the discovery of an infiltrate of minimal degree in his right upper lobe on a chest film. In addition, a smooth rounded tumor was seen in the right lower thorax extending into the major fissure (Fig. 3 and 4). The patient was completely asymptomatic. Past history revealed that he had been in another hospital two years previously for multiple pelvic and femoral fractures incurred by a 40 foot fall to a cement sidewalk. The right diaphragm had been noted to be irregular in an abdominal roentgenogram made at that time, although hernia was not suspected. Study of the patient offered no additional information. Gastric washings were negative for tubercle bacillus and a bronchogram was noncontributory. The diagnosis of transdiaphragmatic hernia was not considered. Exploratory thoracotomy by Dr. Sanford

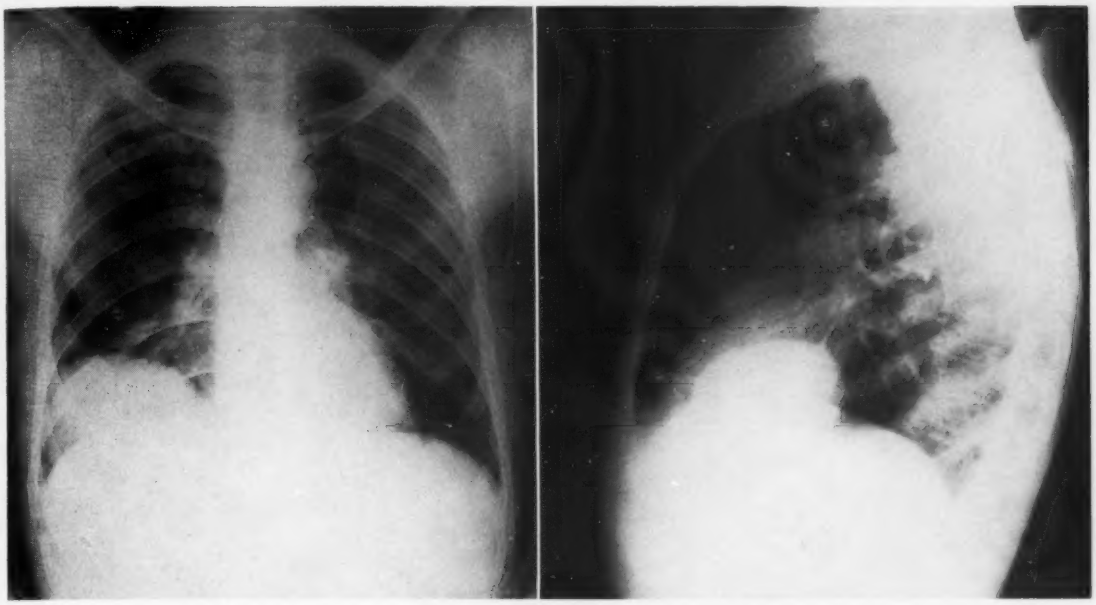

Fig. 3. Case III. Type II traumatic liver herniation proved at operation. The liver mass is smooth as it projects through the diaphragm. It moved with the right hemidiaphragm which showed normal respiratory mobility. Note projection into major fissure.

Fig. 4. Same as Figure 3, lateral view.

Blank revealed a 5 cm. circular tear in the central tendon of the right hemidiaphragm through which protruded a polypoid mass of liver separating the right lower and middle lobes of the lung. The diaphragmatic defect had to be enlarged to replace the liver in the abdomen, but this was accomplished with ease. There was no recurrence of the hernia postoperatively.

Comment. This case is an example of the partial (Type II) liver hernia, the most common type. These are especially difficult to diagnose and Harrington has stated that such cases will usually be mistaken for pulmonary tumor. Pneumoperitoneum, as discussed below, is necessary for correct preoperative diagnosis. Whether the small neck present here would allow entrance of air into the thorax is not certain. The value of a routine chest roentgenogram in cases of severe trauma is again shown.

Case IV. A twenty-nine year old white major was admitted to the William Beaumont Army Hospital in April, 1953. Eight years previously he had been in an airplane accident, and suffered fractures of the skull, pelvis, both ankles, and several ribs on the right side. Although unconscious for two days, he made an uneventful recovery. One year prior to the present admission he began to notice dyspnea when flying above 10,000 feet. A chest roentgenogram was accordingly made (Fig. 5) and showed an elevated, irregular radiopaque density in the right lower thorax obscuring the right hemidiaphragm. Several gas shadows were seen within this density. A barium enema study (Fig. 6) demonstrated extension of the hepatic flexure of the colon through the region of the right hemidiaphragm. An upper gastrointestinal series showed tension on the antrum and duodenal bulb, with these structures pulled superiorly toward the right diaphragm. The lower border of the liver was elevated.

At operation the hepatic flexure of the colon, the superior one-half of the liver, and the gallbladder were found lying in the chest extending through a 3 by 4 cm. tear in the dome of the right hemidiaphragm. The abdominal contents were replaced, the defect repaired, and subsequent recovery was uneventful.

Comment. This case differs from the first three in that the irregular nature of the right diaphragmatic contour and the intrinsic air densities suggested the presence of intestine in the hernial sac. The barium

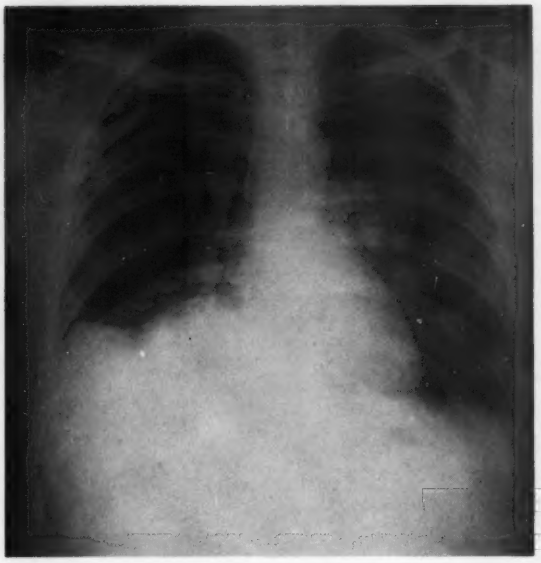

Fig. 5. Case iv. Herniation of liver and hepatic flexure of the colon (Type iii). Note the irregular outline of the density in the right lower thorax. The reproduction does not show the intrinsic gas densities seen on the original film.

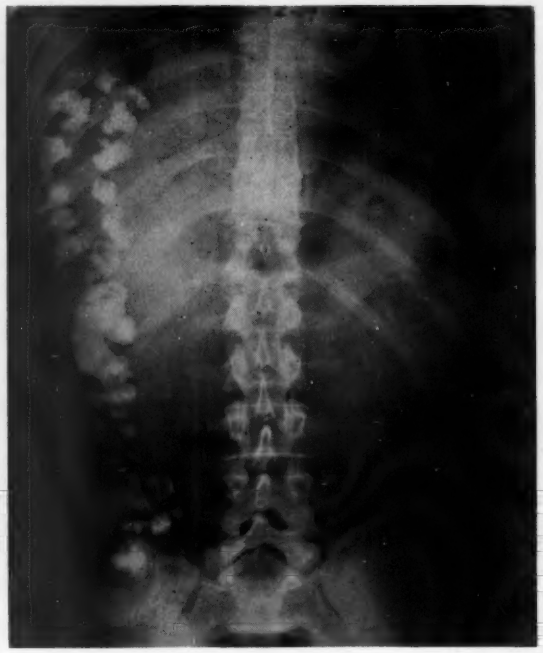

Fig. 6. Case iv. Barium enema study (postevacuation) showing extension of the hepatic flexure into the thorax.

enema study confirmed this. Operation revealed a Type iii liver hernia containing other abdominal elements in addition to liver.

A review of the literature has disclosed 19 additional reports of right-sided traumatic liver herniation. These cases and the 4 reported above are summarized in Table i. The 23 cases all had severe trauma, frequently so severe that the patient was often moribund on admission. In 17 the

Table I

LIVER HERNIA

Author and Year	Age	Sex	Type of Trauma	Associated Injuries	Asymptomatic Period	Symptoms	Type of Liver Hernia	Comment
Keene and Copleman[11] 1945	25	M	Airplane acc. 3 mo. before	Frac. femur, radius, and ulna	3 mo.	Dull right chest pain	I	Functioning gallbladder seen in chest
Kleitsch, *et al.*[12] 1949	54	M	Auto acc. 6½ yr. before	Frac. ribs and pelvis	6½ yr.	Shock after incarceration of colon	I–III	
Knoepp[13] 1951	59	M	Stab right chest, 18 yr. before	None	None	Dull right chest pain 18 yr., sob 6 mo.	I	Pneumoperitoneum used in diagnosis
Floyd[6] 1953	36	M	Mine acc. 2 yr. before	Frac. ribs, vert. and pelvis	None	Shortness of breath, indigestion	I	Pneumoperitoneum used and correct preoperative diagnosis made
Shefts[19] 1955	21	F	Auto acc. 24 hr. before	Frac. pelvis and femur	None	Not known	I	Manual compression of herniated liver allowed 25 per cent reduction in size thus permitting its replacement in abdomen at thoracotomy

TABLE I (*Continued*)

Author and Year	Age	Sex	Type of Trauma	Associated Injuries	Asymptomatic Period	Symptoms	Type of Liver Hernia	Comment
Peck 1957	60	M	Auto acc.	Frac. right ribs and skull	None	Unconscious	I	Chest film suggestive; proved at necropsy
Peck 1957	60	M	Auto acc.	Frac. tibia, fibula and ulna	None	Rt. upper quadrant pain, cyanosis	I	Chest film and chest fluoroscopy proved diagnostic
Wagner[22] 1945	24	M	Kicked in chest	None	2 yr.	Precordial pain, cardiac arrhythmia	II	No preoperative diagnosis
Hughes, *et al.*[10] 1948	40	M	Bullet wound	None	6 mo.	None	II	Door knob herniation of liver on right. No preoperative diagnosis
Hughes, *et al.*[10] 1948	28	M	Shrapnel wound	None	18 mo.	None	II	Door knob herniation of liver on right. No preoperative diagnosis
Hughes, *et al.*[10] 1948	28	M	Auto acc.	Contused chest	6 mo.	Pain right chest	II	Door knob herniation of liver on right. No preoperative diagnosis
Hughes, *et al.*[10] 1948	33	M	Shrapnel wound	Superficial wounds	15 mo.	None	II	Door knob herniation of liver on right. No preoperative diagnosis
Rogers and Leigh[18] 1953	50	M	Auto acc. 2½ yr. before	Severe bruises over right chest	None	Cramping abdominal pain	II	No preoperative diagnosis
Rabin[15] 1952	9	M	Auto acc. 5 yr. before	None		None	II	Pneumoperitoneum permitted preoperative diagnosis
Child, *et al.*[3] 1951	63	M	Fell 75 feet 44 yr. before	Multiple fractures	32 yr.	Epigastric pain post-prandial, 12 yr.	II	Operation gave relief of symptoms
Shoshkes and Lovelock[20] 1953	27	M	Kicked in right chest 10 yr. before	None		None	II	Pneumoperitoneum permitted preoperative diagnosis
Peck 1957	27	M	40 foot fall 2 yr. before	Frac. pelvic and femur		None	II	Diagnosed at surgery
Rives[16] 1953		M	Run over by truck 20 yr. before	Unstated		Unstated	III	One-half liver, ½ colon, ½ stomach in chest
Strode and Vance[21] 1953	29	M	Crushed in mine cave-in 2 yr. before	Fract. multiple ribs 18 mo. and L-1-2 vert.	18 mo.	Smothering spells gurgling in chest, vomiting	III	Rt. lobe of liver, gallbladder, transv. colon, part of jejunum in right chest
Neal[14] 1953	31	M	Crushing injury to trunk 4 yr. before	None	6 mo.	Pain in right chest, nausea with vomiting, gurgling in chest after meals	III	Entire liver, stomach hepatic flexure in right thoracic cavity
Peck 1957	29	M	Airplane acc. 8 yr. before	Frac. skull, pelvis and ribs	2 yr.	Dyspnea in airplanes	III	Incarceration of hepatic flexure on barium enema study allowed correct preoperative diagnosis

Harrington's[8] 2 cases did not have the above data recorded.
Ancillary data in the above cases obtained by personal communication.

trauma resulted from nonpenetrating injury, in 4 there had been penetrating injury, and in 2 the nature of the trauma was not stated. The site of diaphragmatic rupture could not be correlated with any point of embryonic fusion or hiatus, or with any specific type of trauma.

Prompt diagnosis of this hernia has been the exception and not the rule with the longest interval between trauma and diagnosis being forty-four years. Furthermore, after the initial symptoms of trauma subsided there was frequently a latent asymptomatic period varying from three months to thirty-two years. This asymptomatic period has also been emphasized by Carter, Giuseffi, and Felson,[1] in the more common left-sided traumatic herniation.

SYMPTOMS AND SIGNS

Symptoms were present in 12 of the 20 cases (60 per cent) in which such information was available. Most commonly these symptoms were non-specific, consisting of vague chest pain or epigastric pain, and occasional shortness of breath. Complete liver hernia (Type I) patients were symptomatic at some period in 5 out of 7 cases. One additional patient in this group died without regaining consciousness (Case 1) and in another the presence of symptoms was unknown. Only 2 out of 10 (20 per cent) of Type II cases were noted to have symptoms referable to their hernia. The Type III hernias produce symptoms similar to those commonly associated with left-sided diaphragmatic hernia, such as nausea, vomiting, gurgles in the chest, cardiorespiratory symptoms and occasionally shock.

Kleitch and co-workers[12] reported a Type I hernia which was asymptomatic for six and a half years and then became symptomatic when the colon also herniated through the right diaphragmatic defect (Type I changing to Type III). The shock-like picture frequently associated with acute incarceration of portions of the gastrointestinal tract has been noted by others.[1] Dutlinger and Fluke[4] described a similar instance in a seventy year old man, although in this case the liver was presumed to have been congenitally herniated through a defective right hemidiaphragm.

The lack of more specific symptoms and signs has made clinical examination of limited value, although in our second case an alert examiner percussed a high right diaphragm and noted right upper quadrant muscular spasm immediately after the injury. When peristaltic sounds are heard in the right chest, it suggests the more common congenital foramen of Morgagni hernia. With a history of severe trauma at any time in the past, this sign should suggest hernia of the Type III variety.

A preoperative diagnosis of liver hernia has been made in only 9 instances. Hence, the majority have been operated upon because of a lower right thoracic density usually considered to be supradiaphragmatic in origin. With a greater awareness of the condition, a history of past trauma should be readily obtainable. Then, through the use of some of the methods discussed below, preoperative diagnosis should be made more often in the future.

ROENTGEN CONSIDERATIONS

Isolated right-sided liver hernia will produce one of two pictures, depending on the size of the diaphragmatic defect. In total liver herniation (Type I) there will be a high, smooth arcuate shadow (Fig. 1). In Type II hernia the smaller diaphragmatic defect will allow a mass of hepatic tissue to "mushroom" into the lower right chest cavity (Fig. 3). The Type I hernias must be differentiated from all the entities which produce or mimic a high right diaphragm, and the Type II hernias must be differentiated from any of the numerous causes of localized densities in close relationship to the diaphragm. An irregular border of a mass projecting into the right lower thoracic cavity should make one consider hernia containing other abdominal organs either with liver (Type III) or without it.

In addition to the smooth upper border projecting into the chest, identification of an abnormally high inferior liver border is an important sign in Type I hernias. The

presence of this sign in the case of Kleitch and his co-workers[12] (Table 1) would have made untenable the original diagnosis of basal pleurisy. In Keene and Copleman's[11] report (Table 1) the location of the lower hepatic margin on the initial abdominal film suggested the correct diagnosis.

Chest fluoroscopy, as in our second case, may be helpful in making an early diagnosis in Type 1 lesions. Occasionally the torn medial or lateral right diaphragmatic leaf can be seen moving in unison with the normal left hemidiaphragm. This indicates a large tear. Fluoroscopy also may assist in differentiating inflammatory subphrenic disease with elevation of the right hemidiaphragm as in such cases there is usually immobility of the diaphragm. Knowledge of previous abdominal inflammatory disease, and superimposed lung and pleural changes are also helpful in the differential diagnosis.

Diagnostic pneumoperitoneum is a procedure which may be of prime importance in establishing the diagnosis. The injected air will frequently enter the hernia, thus establishing the relative position of the herniated structure and the diaphragm. Pneumothorax has not been noted in the 4 instances reported where pneumoperitoneum was diagnostic. This suggests that the visceral pleura does not tear at the time the diaphragm ruptures and/or that the peritoneum remains intact. Rabin[15] states that incomplete delineation of the undersurface of the right hemidiaphragm in properly positioned pneumoperitoneum films suggests liver hernia. A diaphragmatic tumor could also account for an irregular inferior diaphragmatic contour on pneumoperitoneum. The absence, on occasion, of complete visualization of the hernia by means of injected air is explained by Clay and Hanlon[2] as being caused by incorporation of the extraperitoneal superior surface of the liver in the sac. Adhesions may also exclude injected air from the hernia.

Pneumoperitoneum will differentiate liver hernia of Type 1 from cases of severe thoracic cage trauma with a temporarily elevated, splinted diaphragm, and from patients with complete paralysis of the diaphragm.

The differentiation of the rare right-sided eventration from a Type 1 liver hernia cannot be made on the single postero-anterior roentgenogram of the chest. True eventration as described by Clay and Hanlon represents a rare congenital lesion secondary to various poorly understood congenital lesions of the phrenic nerve or the diaphragm itself. The diagnosis of an eventrated right hemidiaphragm should be clear following pneumoperitoneum. A history of severe trauma and/or a previous normal chest roentgenogram will be evidence against eventration. Hepatic enlargement offers little difficulty in diagnosis. Although the diaphragm may be smoothly elevated, the inferior hepatic border retains its normal position or extends downward displacing the stomach and hepatic flexure.

Infrapulmonary fluid simulating a high right diaphragm should be considered in the differential diagnosis.[6] As much as 1000 cc. may be present in the chest without giving the costophrenic angle curvilinear shadow usually considered characteristic of free pleural fluid. Figure 7 shows such a case in a young male admitted to William Beaumont Army Hospital after severe trauma to the chest. The apparent elevation of the right hemidiaphragm and associated right rib cage fractures made us consider a Type 1 liver hernia. However, the lower border of the liver was not abnormally high. A supine chest roentgenogram (Fig. 8) demonstrated the free fluid collection in the posterior pleural space and the right diaphragm in normal position. One thousand cc. of sterile fluid was aspirated shortly thereafter.

Partial liver herniation (Type 11) as mentioned above presents as a rounded mass superimposed on the lower thorax. The right hemidiaphragm will remain visible over most of its course, and appear normally situated. Special care should be exercised in searching for loss in continuity of the right hemidiaphragm which would indicate contact of a poorly visualized hernia neck with the diaphragm at the

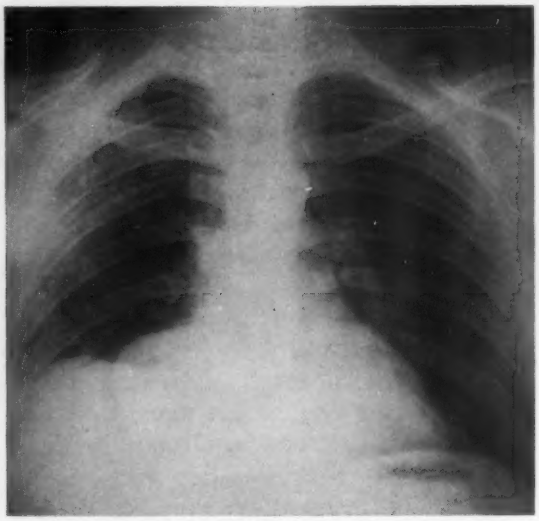

Fig. 7. Upright view. Infrapulmonary pleural fluid following chest trauma.

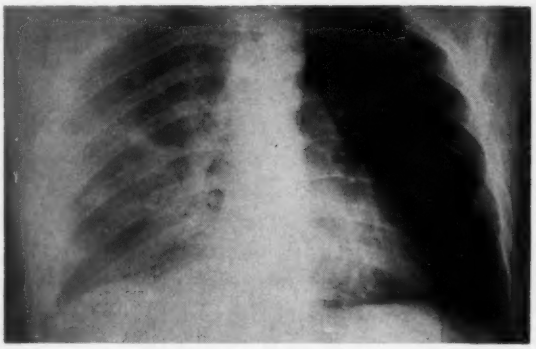

Fig. 8. Same as Figure 7, recumbent view. The free fluid fills the posterior pleural space and the right hemidiaphragm is now visible in normal position.

point of actual herniation.

In differential diagnosis neoplasm of the lung, pleura, or diaphragm must be considered. The only method of diagnostic value is pneumoperitoneum, and no case has been correctly diagnosed without its use. It should be performed in any case presenting a mass which is inseparable from the diaphragm and not otherwise characteristic of a specific process.

The segment of herniated liver will occasionally lie in the right cardiophrenic angle. The two most common lesions to be differentiated in such cases are pericardial celomic cysts and foramen of Morgagni hernias.[18] If the pericardial cyst or diverticulum is small, it may present in the major fissure and, on lateral view, it will have a fairly characteristic tear drop configuration. Larger pericardial cysts are usually diagnosed at thoracotomy, although they will ordinarily move independently of the diaphragm on fluoroscopy.

Foramen of Morgagni hernia can be identified by routine posteroanterior and lateral chest roentgenograms by the presence of gas-containing intestine anteriorly just lateral to the sternum. If only omentum is present in the hernia, the transverse colon will be "peaked" toward the herniated site because of traction by the herniated omentum. Barium enema study may be indicated to better delineate the position of the colon.

One other confusing lesion, the exact definition of which is obscure, is the so-called anomalous lobe of the liver.[7–17] This lesion presents in the right anterior cardiophrenic angle. Pneumoperitoneum will show an attenuated but intact diaphragm over the liver mass. These ectopic masses of liver substance do not have true septa to indicate a congenital origin, and most authors believe them secondary to a defective diaphragm. The liver can undergo considerable alteration in shape, as shown by its mushroom appearance in Type II herniation, and, for this reason, the lesion under discussion is probably best considered to be partial nontraumatic herniation of the liver. Shoshkes and Lovelock[20] have pointed out that their Type II hernia fulfilled the accepted critera for an anomalous lobe of the liver as seen on pneumoperitoneum. Figures 9 and 10 show posteroanterior and lateral chest roentgenograms in a similar case discovered in a thirty-five year old male farm worker with no history of trauma. He was asymptomatic. The right lower chest mass was presumed to be a part of the liver since the inferior border outlined by air-filled intestine appeared abnormally high on the frontal projection. A diagnostic pneumoperitoneum demonstrated an intact right hemidiaphragm which was thinned anteriorly. The large

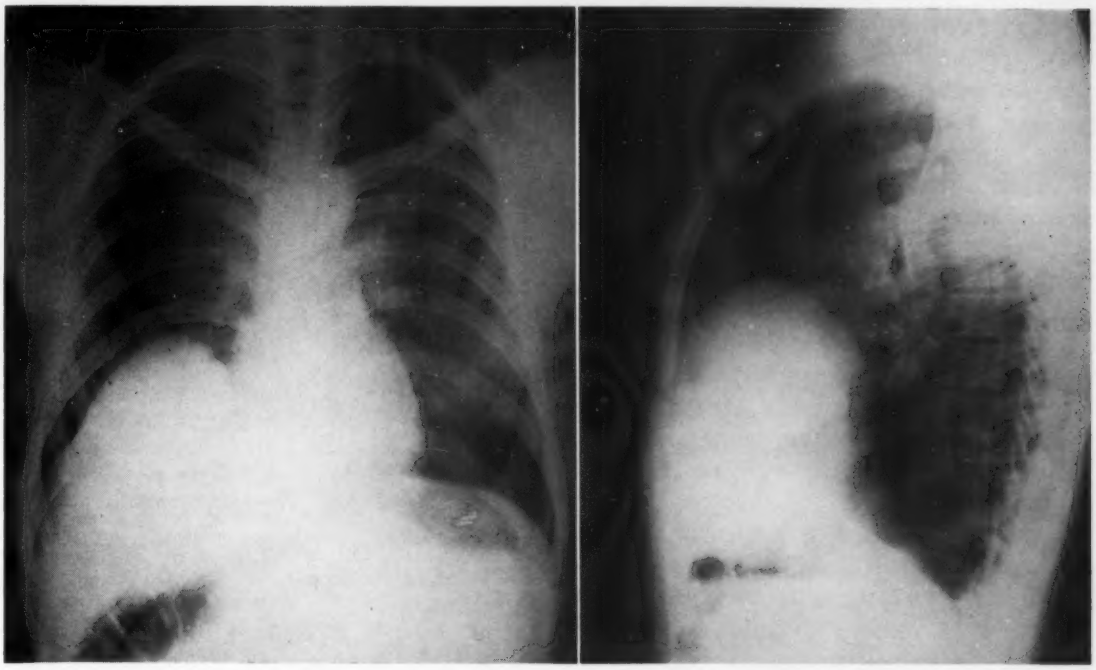

Fig. 9. "Congenital hernia" of the liver, secondary to an atrophic anterior diaphragmatic segment. Note the elevated inferior surface of the liver as outlined by the gas-filled intestine.
Fig. 10. Same as Figure 9, lateral view.

mass beneath this segment of the diaphragm is undoubtedly liver. It was displaced into the abdominal cavity by the peritoneal air (Fig. 11).

The irregular superior margin of the mass as seen in Type III liver hernia is not pathognomonic, of course, but should lead to a suspicion of diaphragmatic hernia. If such a situation exists, barium studies will locate a point of constriction or obstruction at the diaphragmatic defect and may show the herniated intestine entering and leaving the chest cavity at the point which represents the hernial ring.[1]

In the final analysis, the diagnosis of traumatic right-sided diaphragmatic hernia of the liver rests upon an awareness of this entity, a clear history of severe trauma, and appropriate roentgen studies to confirm its presence.

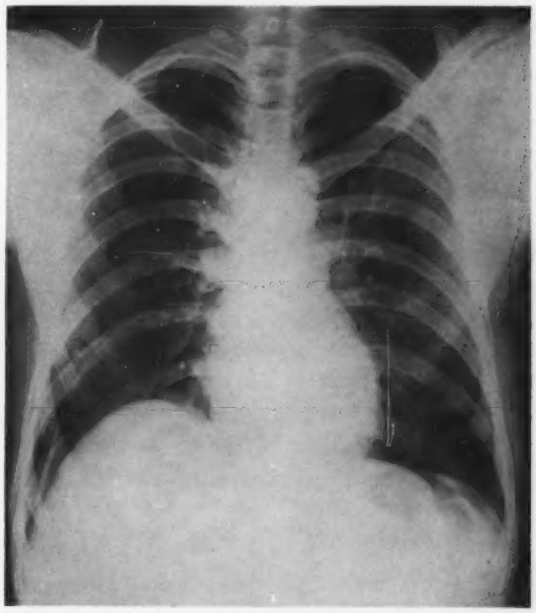

Fig. 11. Pneumoperitoneum in same case as Figures 9 and 10 demonstrating an elevated, atrophic but intact anterior segment of the diaphragm superior to the liver mass.

SUMMARY

1. Herniation of the liver through the right hemidiaphragm following trauma is relatively rare. Four cases in addition to the 19 previously reported in the literature are reviewed.

2. The entire liver or only a part of it may herniate into the thorax. Other elements of the gastrointestinal tract may herniate on occasion.

3. Symptoms are present in the majority of cases, but are nonspecific in nature. An asymptomatic interval following trauma is frequently noted, varying from three months to thirty-two years.

4. Accurate preoperative diagnosis depends entirely upon roentgen procedures. Routine chest roentgenograms, chest fluoroscopy, barium studies, and diagnostic pneumoperitoneum have been helpful. Pneumoperitoneum is a most valuable diagnostic aid.

5. With an awareness of this condition, a history of severe trauma, and appropriate roentgenologic studies following the discovery of a density in the right lower thorax, the correct preoperative diagnosis should be made in almost all cases.

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Dr. Benjamin Felson, Professor of Radiology, University of Cincinnati, and Dr. James Gunn aided materially in the preparation of this paper. Dr. Sanford Blank and Col. Jack Rush kindly allowed me to use their cases.

ADDENDUM

Hollander and Dugan have reported 4 additional cases of Type II liver hernias since this paper was accepted for publication. Hollander, A. G., and Dugan, D. J. Herniation of the liver. *J. Thoracic Surg.*, 1955, *29*, 357–367.

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THE MINERAL CONTENT OF BONE TUMORS AND ITS INFLUENCE ON RADIATION TUMOR DOSE*

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WHETHER or not the biologic effects of a given dose of ionizing radiation vary according to the wave length of the radiation used has long been a matter of debate among radiotherapists and radiation physicists. At this time the question is among the most urgent requiring solution, for the further development of radiation therapy depends largely on equipping it with the best apparatus. The question is one of great complexity, and one which cannot be resolved by a purely mathematical and physical approach. For example, Bunsen's law according to which the effect is proportional to the product of intensity and time, does not hold for biologic material where vital reactions such as homeostasis change the biologic result of radiation doses given at different intensities. Even in so apparently simple a reaction as skin erythema, the most exhaustive measurements failed to produce a physical explanation for the variation of erythema dose with wave length, except for a possible correlation with specific ionization.[2] Gray[3] came to the general conclusion that, "The chemical changes initiated along the track of a particle when it is traveling at high speed differ not merely in degree but in kind from those which it will initiate when traveling slowly."

In the radiation therapy of cancer, empirical data such as five-year survival rates afford some guidance in the selection of the most effective quality of radiation and appropriate tumor dose, but the effect of a given tumor dose in any individual patient is completely unpredictable for three main reasons: (1) No 2 patients and no 2 tumors are ever likely to be exactly alike; (2) the series of biologic chain reactions initiated by irradiation await elucidation; and (3) the amount of radiation absorbed and its distribution among the fine structures of the cells are imprecisely known.

The amount of radiation absorbed depends upon the chemical composition of the tissue, and its distribution varies with wave length. Precise measurements of both amount and distribution are a necessary preliminary step before the question of biologic variations can be approached. The "cure" of cancer by radiation therapy presumably results from the combination of an irreversible injury to the malignant process with preservation of, or at most a recoverable injury to, the normal tissues. The poor results of radiation therapy both in osteogenic sarcoma and in Ewing's tumor of bone, the one so "radioresistant" and the other so "radiosensitive," suggest the need of a fresh approach to the problem of their treatment.

It is well known from the work of Spiers[4] that the energy absorbed by dense cortical human bone from a beam of roentgen rays generated at about 200 kv. peak may be four to five times as great as that absorbed by soft tissues, while the energy absorbed by bone from 1,000 kv. peak roentgen rays exceeds that absorbed by soft tissue by only about 50 per cent. However, Spiers[5] and Wilson[6] have pointed out that the energy absorbed by the bone minerals themselves is not important biologically, the biologic damage being due to the secondary electrons generated in the bone salt and adsorbed by nearby masses of soft tissue. These authors have calculated the range in soft tissue of the secondary electrons generated in bone salt exposed

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to roentgen rays of different energies. In this way they have found the amount of energy which may be expected to be absorbed in soft tissue masses of different sizes adjacent to, or embedded in, bone. Woodard and Spiers[8] have been able to confirm the correctness of these predictions in a living biologic system by making quantitative measurements of the loss of alkaline phosphatase activity in irradiated mouse bones.

The dimensions of some of the soft tissue structures in compact human bone are shown well in the figure by Maximov and Bloom quoted by Wilson.[6] The average distance of the soft tissues from bone salt varies from less than 5 microns in the canalicules and lacunae to about 25 microns in the lumina of the haversian canals. Structures of this size will be damaged maximally by 100 kv. peak to 250 kv. peak roentgen rays. It is obviously impossible to draw definite conclusions about the average dimensions of the various parts of heterogeneous tissues such as osteogenic sarcomas, but a rough estimate may be made from the microradiographs of sections of several of these tumors which have been published by Engfeldt.[1] These show that, even in sclerosing tumors, much of the soft tissue is 50 to 100 microns distant from calcific material. In soft tissue masses of this size, the contribution of secondary electrons from the calcific material to the total energy received from exposure to roentgen rays of 200 to 250 kv. peak is much less important than it is in the smaller structures in normal cortical bone. For roentgen rays generated at voltages above 500 kv. peak, the ionization in even quite small soft tissue masses embedded in bone differs little from that in soft tissue remote from bone.[5] The relative amounts of damage due to the secondary radiation from bone salts which will occur in the soft tissues of osteogenic sarcoma and of normal bone thus depend on the relative dimensions of the soft tissue masses. This is difficult to evaluate because of the variable structure of the tumor tissue, although it is probably less in the tumor than in the normal bone. The absolute quantity of secondary radiation depends on the amount of bone salt present, and this can be determined by analysis of the tissues in question. The purpose of this paper is to present the results of such analyses.

MATERIALS AND METHODS

All of the tissues were obtained fresh from operative specimens with the exception of those from Case 12, which were obtained at autopsy. After the overlying soft parts had been removed, the bone was sectioned with a band saw. Representative portions of tumor or of normal bone were then selected for analysis, necrotic or hemorrhagic areas being discarded. The specimens of normal bone were taken from regions remote from the tumor, except in Cases 11, 23, and 26, where the normal bone selected was only 2 or 3 cm. from the tumor margin. The specimens usually weighed 1 to 5 gm.

If phosphatase was to be determined, the specimens were morcellated, twenty parts of water were added, and the enzyme was allowed to extract for 48 to 96 hours. This process did not result in the removal of demonstrable amounts of calcium. The extract containing the phosphatase was removed by filtration or centrifugation, and the solid residue was used for the determination of calcium. When phosphatase was not to be determined, the specimens were processed for calcium without preliminary extraction.

The method for tissue phosphatase has been described by one of us elsewhere.[7] In the determination of calcium, the tissues were digested with concentrated sulfuric acid and then ignited to a white ash in a muffle furnace. The ash was taken up in hydrochloric acid and made up to volume. Aliquots were then made alkaline with ammonia, and the calcium precipitated as the oxalate. The precipitate was centrifuged, washed, dissolved in hot normal sulfuric acid, and titrated against standard permanganate.

RESULTS

The results are summarized in Table 1. The tumor diagnoses given are those reported by the Department of Pathology of Memorial Hospital. Histologic examinations of the specimens of normal bone were not made.

The alkaline phosphatase activities of some specimens are shown as an aid in evaluating the active mass of the different parts of the tumors. Some types of osteogenic sarcoma, especially the fibrosarcomas and certain chondrosarcomas, elaborate little or no alkaline phosphatase. Other tumors produce the enzyme in great abundance. In the latter type, the relative phosphatase activities of different parts of the tumor give a rough indication of the relative amounts of actively metabolizing tissue present. The comparison is not rigid, since some tumors contain several different cell types. Case 7 is an example. In this tumor, the cartilaginous part of the periphery contained much less phosphatase than the calcifying part, although both appeared to be growing rapidly. The heavily calcified central portion, which was not cartilaginous, contained little phosphatase, the low reading in this case presumably being due to the small amount of active tumor present.

In the six specimens of normal cortical bone from the femur, tibia or humerus of adults or adolescents, the calcium content varied only over the narrow range from 18.7 to 22.6 gm. per 100 gm. wet weight of bone. The calcium content of the cortical bone from the rib or scapula was somewhat lower. This probably indicates that the bones were actually less dense, especially as one (Case 26) was obtained from a child, but may also indicate that some spongiosa was unavoidably included with the cortex. As is to be expected, the calcium content of the three specimens of spongiosa (Cases 1, 11 and 27) was low and variable. It is interesting that the cortical bone from the clavicle of a child (Case 25) was found to be as densely calcified as the cortex of the long bones of the adults.

Thirty-one specimens of osteogenic sarcoma tissue were taken from 19 tumors. Of the 31, 18 had less than 1 gm. of calcium per 100 gm. of wet weight. The calcium content of the remaining 13 specimens varied from about 2 to 11 gm. per 100 gm. The tumors consisting mainly of fibrosarcomatous tissue (Cases 9, 13 and 14) were essentially uncalcified, as was the sarcoma arising on Paget's disease (Case 5). In sarcomas consisting mainly or partly of cartilage (Cases 1, 4 and 7), the cartilaginous areas were only lightly calcified, as was also true in the benign osteochondroma (Case 2). In tumors or portions of tumors which consisted mainly of bone-forming elements, the peripheral portions were less calcified than the centers. An example is Case 7, in which area B had the typical sun-ray appearance of a bone-forming sarcoma, but contained only one fifth as much calcium as area C. In this case, and in the tumors of Cases 18 and 20, the alkaline phosphatase activities of the different specimens suggest that the heavily calcified portions contained comparatively little active tissue. In the metastatic nodule from the lung in Case 12, the center was more heavily calcified than the periphery, although there was no great difference in the phosphatase activities.

The radiation therapist is dependent on the roentgenographic appearance of a lesion in evaluating its degree of mineralization. Hence it seemed of interest, in Figure 1, to show a roentgenogram of the lesions in Case 21, together with a tracing to show the areas from which the specimens were obtained. This was an unusual case of two separate primary osteogenic sarcomas arising in the lower femur and upper tibia, possibly on an underlying fibrous dysplasia. There is a fair correlation between the apparent and actual degrees of calcification in the different parts.

DISCUSSION

Since the actively-growing portions of a primary bone sarcoma contain only small amounts of bone salts, the quantity of

TABLE I

Case No.	Age and Sex	Tissue		Tissue Calcium gm./100 gm.	Tissue Alkaline Phosphatase units/gm.
1. A.C.	M 20	chondrosarcoma, radius		0.06	
		normal cortex, humerus		22.3	
		normal spongiosa and marrow		0.4	
2. P.M.	M 21	osteochondroma, humerus, bony		11.9	
		osteochondroma, humerus, cartilaginous		1.1	
3. H.D.	F 20	osteogenic sarcoma, femur			
		osteogenic sarcoma, center		4.4	
		osteogenic sarcoma, periphery		4.5	
4. N.B.	M 52	osteochondrosarcoma, femur			
		osteochondrosarcoma, sclerosing		4.5	
		osteochondrosarcoma, soft		0	
		normal cortex, femur		21.7	
5. J.Z.	M 65	osteogenic sarcoma arising on Paget's disease, humerus		0.1	
		Pagetoid bone, humerus		11.1	
6. J.M.	M 26	sclerosing osteogenic sarcoma, femur		8.5	
7. R.M.	M 18	osteogenic sarcoma, femur			
		osteogenic sarcoma, periphery, cartilaginous	A	0.6	2.1
		osteogenic sarcoma, periphery, calcifying	B	1.9	44.0
		osteogenic sarcoma, center, sclerosing	C	9.9	0.6
8. C.M.	M 16	osteogenic sarcoma, femur		11.1	
9. M.S.	F 35	parosteal osteogenic sarcoma, tibia		0.07	
10. T.P.	M 19	osteogenic sarcoma, tibia,			
		osteogenic sarcoma, periphery, soft		0.1	
11. E.R.	M 14	osteogenic sarcoma, femur			
		osteogenic sarcoma, periphery, soft		0.5	45.0
		osteogenic sarcoma, invading spongiosa		8.2	10.1
		normal epiphyseal spongiosa		7.8	4.3
12. N.G.	M 27	metastases from osetogenic sarcoma			
		nodule from lung, periphery		0.1	63.0
		nodule from lung, center		0.9	45.0
		nodule from psoas muscle		0.7	39.0
13. E.S.	F 31	fibrosarcoma, humerus		0	
14. M.K.	M 11	medullary fibrosarcoma, tibia		0.04	
15. R.B.	F 15	chondromyxosarcoma, femur			
		chondromyxosarcoma, periphery, soft		0.4	24.5
		chondromyxosarcoma, center, sclerosing		7.5	15.3

Table I—(*Continued*)

Case No.	Age and Sex	Tissue		Tissue Calcium gm./100 gm.	Tissue Alkaline Phosphatase units/gm.
16. P.K.	M 78	osteogenic sarcoma, femur		0.04	
17. J.C.	M 11	anaplastic osteogenic sarcoma, femur		0.1	
18. A.K.	M 7	osteogenic sarcoma, femur			
		osteogenic sarcoma, center, sclerosing		7.1	15.0
		osteogenic sarcoma, periphery, soft		0.7	49.0
19. A.B.	M 26	osteogenic sarcoma, femur, mixed with spongiosa		5.9	
20. B.A.	M 18	osteogenic sarcoma, femur			
		osteogenic sarcoma, center, sclerosing		6.5	2.6
		osteogenic sarcoma, periphery, soft		0.02	11.2
		normal cortex, femur		20.3	
21. J.F.	M 17	osteogenic sarcoma, femur			
		osteogenic sarcoma, periphery, soft	(A)	0.01	4.2
		osteogenic sarcoma, center, sclerosing	(B)	9.8	5.4
		osteogenic sarcoma, tibia, soft	(C)	0.9	102
		normal cortex, tibia	(D)	19.9	
22. E.C.	F 15	normal cortex, femur		18.7	
23. B.H.	F 42	normal cortex, rib		16.9	
24. J.W.	F 54	normal cortex, rib		13.2	
25. S.R.	M 11	normal cortex, clavicle		20.0	
26. M.M.	F 10	normal cortex, scapula		14.3	
27. H.W.	M 45	normal cortex, femur		22.6	
		normal spongiosa, head femur		10.4	

secondary radiation from such bone salts is only an insignificant fraction of the total tumor dose, so that in this respect the quality of the primary radiation is unimportant. In the dense sclerotic portion of the tumor, however, damage to the sarcomatous cells might be much greater from medium voltage than from supervoltage roentgen rays, owing to the more abundant secondary radiation from the higher calcium content. But the calcium content of normal bone cortex is twice that of the densest parts of the osteosarcomas examined here, so that the use of medium-voltage rogenten rays still is likely to produce more damage, so far as the secondary radiation from bone salts is concerned, to normal osteoblasts than to sarcoma cells. If the continuing functioning of osteoblasts and other normal cells has an essential place in the events which follow the successful irradiation of bone sarcomas, then the shorter wave length radiation of telecobalt or supervoltage roentgen apparatus is preferable to the longer wave length radiation of 130 to 400 kv. peak

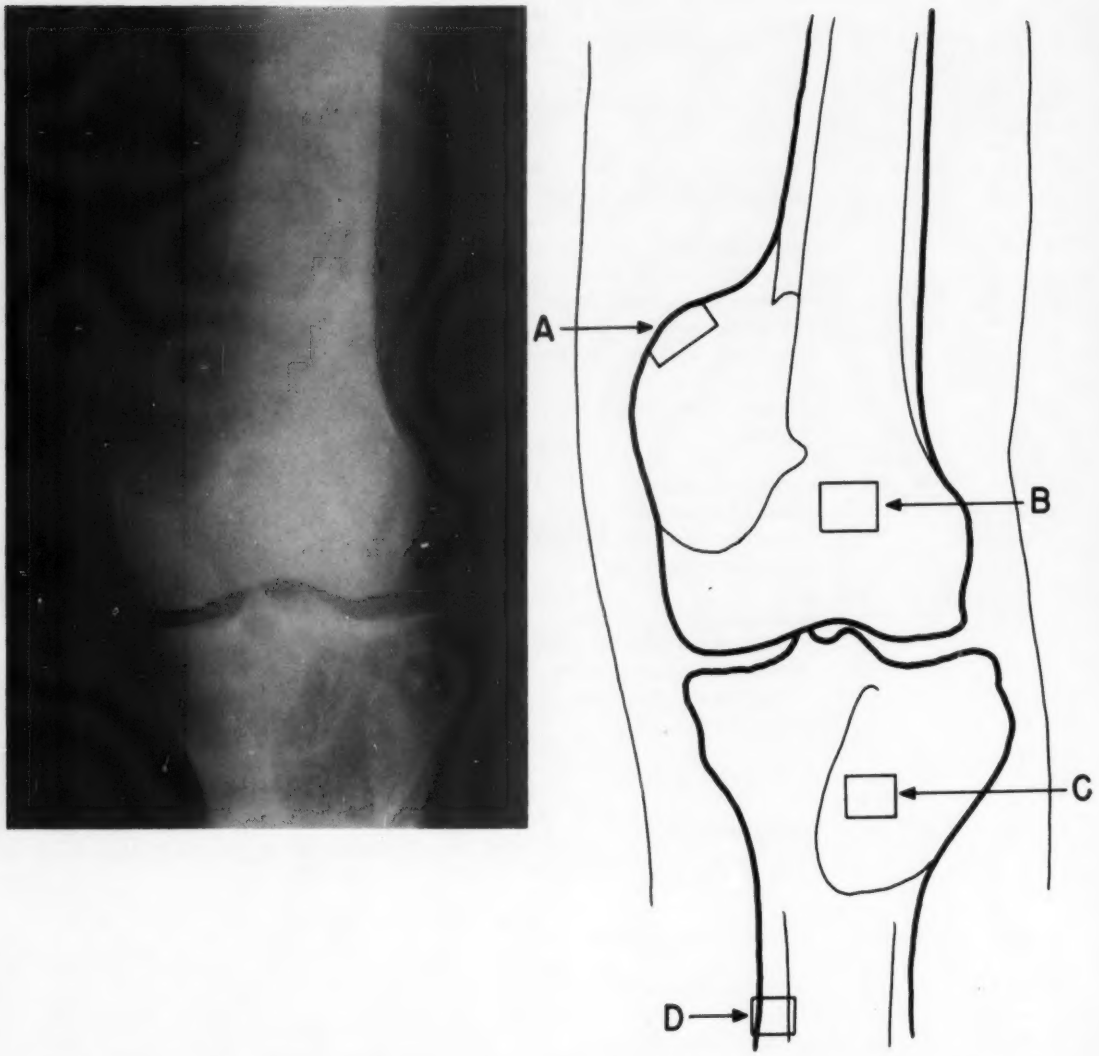

Fig. 1. Case 21. Two separate osteogenic sarcomas arising in the lower femur and upper tibia. The tracing shows the areas from which specimens were taken for chemical analysis.

roentgen apparatus, because the quantity of damaging secondary radiation from bone salts is much less with the former than with the latter.

SUMMARY

1. The calcium content and alkaline phosphatase activity of a variety of osteogenic sarcomas and of corresponding parts of normal bones have been measured.

2. In the bulk of most osteogenic sarcomas, the amount of calcium is seldom more than one fifth, and usually less than one twentieth, that in normal bone.

3. The alkaline phosphatase activities of different parts of the same tumor indicate that the most heavily calcified portions usually contain the least actively metabolizing tumor tissue.

4. These results indicate (a) that the use of those radiations of longer wave length which are strongly absorbed by calcium will not appreciably add to the tumor dose in the irradiation of osteogenic sarcomas

and (b) that the use of those radiations of shorter wave length which are little absorbed by calcium will do much less damage to normal bone with the same tumor dose.

5. The biologic effectiveness of radiations of different wave lengths in the treatment of osteogenic sarcomas is unlikely to be dependent on their content of bone salts.

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THE VISUAL PHYSIOLOGY OF ROENTGEN DIAGNOSIS*

A. BASIC CONCEPTS

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THE perception of anatomic detail in a roentgenogram is a visual process. Yet despite the example of workers such as Chamberlain,[2] Newell and Garneau,[9] and Sturm and Morgan,[11] the principles of visual physiology have not been generally applied to the solution of roentgenologic problems. We believe that the concepts of retinal physiology are basic to the rational development of improved roentgenographic techniques, and for this reason propose here to review some of these concepts and to consider their application to the solution of problems in roentgen diagnosis.

I

Let us begin by noting that in film reading, as opposed to fluoroscopy, we are concerned exclusively with the physiology of photopic vision—mediated by a tightly packed mosaic of receptor cells (the cones) which respond to the stimulus of incident radiant energy by neural discharges. These discharges, resulting from changes in the photochemical equilibria within the cones, initiate the processes which ultimately result in perception.

These receptor cells, or cones, exhibit the characteristic of light adaptation. Exposing them to any constant level of illumination results in a marked decrease in their rate of discharge following an initial burst of activity. Exposing them to a fluctuating level of illumination, however, repeatedly disrupts their photochemical equilibrium and their activity is sustained. The frequency of their discharge varies as a logarithmic function of the difference in illumination to which they are exposed (Fig. 1).

An image projected on the retina during a fixation may be regarded as a pattern of illumination momentarily fixed in space. The retina itself, however, is in constant random motion relative to this pattern of illumination due to so-called fixation nystagmus.[1,6,10] Cones scanning the projected border of the image are, therefore, exposed to a rapidly fluctuating level of illumination[7] such as we just considered, and do, indeed, discharge at a sustained rate. All other cones, despite the motion of the retina, receive a constant illumination to which they very quickly adapt. One's perception of an image depends, then, upon the activity of the cells upon which the image border is projected. This "dynamic"

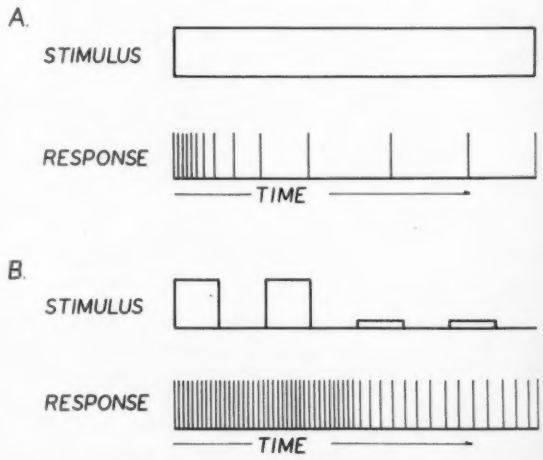

FIG. 1. *The neural response of a retinal receptor cell.* When exposed to a constant level of illumination (A), the activity of the cell decreases to a low level after an initial burst of discharges—the phenomenon of fatigue or light adaptation. The activity of the same cell, when exposed to a fluctuating stimulus (B), is sustained. Its rate of discharge varies as a logarithmic function of the magnitude of the stimulus.

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† Scholar in Radiological Research of the James Picker Foundation.

concept of the perception of a border is illustrated in Figure 2.

In practice, roentgenographic borders are never perfectly "sharp" and their retinal projections are yet more blurred because of the diffraction of light by the pupil.* It is of greater interest, then, to consider the perception of an "unsharp" retinal image border such as that illustrated in Figure 3. In such a case, note that the response of the cones does not depend upon the maximum difference in illumination occurring across the projected border—the physical counterpart of which we call "contrast"—but rather, upon the difference in illumination to which the individual cones around the projected image border are exposed within the distance of their nystagmic excursions. *Cone activity and hence perception, depends, therefore, upon the rate of change of illumination with distance across the retina—the spatial retinal illumination gradient.*

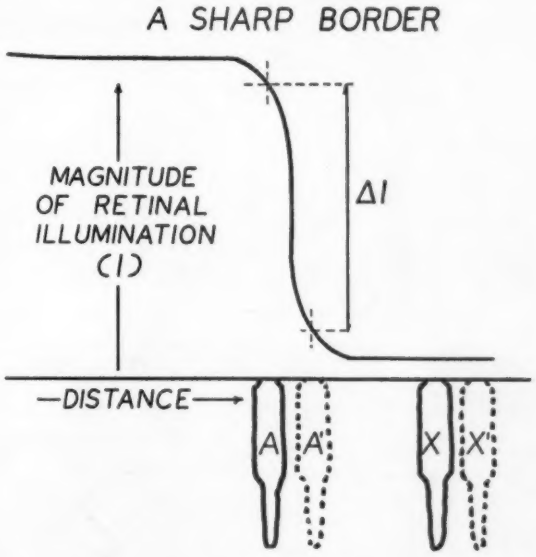


FIG. 2. *The perception of a "sharp" image.* The graph represents a portion of the pattern of retinal illumination produced by a "sharp" image. Below it, two retinal receptor cells (A and X) are pictured. The retina is in constant random motion (fixation nystagmus) as a result of which the cones "oscillate" between positions A-A′ and X-X′ respectively. Cone X is exposed to a constant illumination despite its motion, and therefore, adapts. Cone A, however, scans the image border, is exposed to a wide difference in illumination, ΔI, and discharges continuously. It is this fluctuating illumination of the cones scanning its border which results in the perception of an image.

* When the pupil aperture is large, this effect is minimized but chromatic aberration then becomes significant.

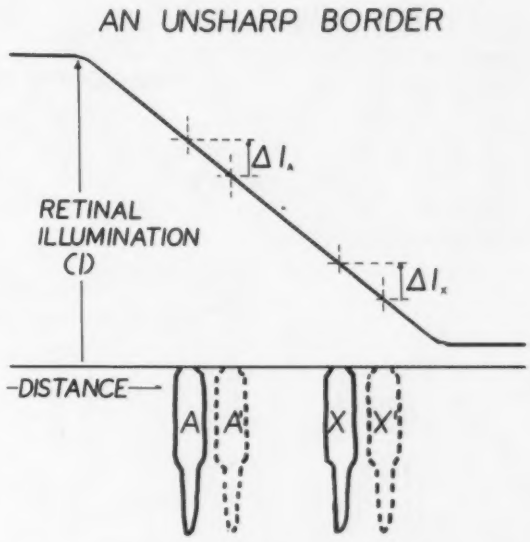


FIG. 3. *The perception of an "unsharp" image.* Again, the retinal illumination pattern has been indicated graphically and the range of motion of two cones (from A to A' and X to X') is indicated. The effective visual stimulus is the difference in illumination (ΔI_A, ΔI_X) to which the individual cones are exposed within the distance through which they move. The magnitude of ΔI_A and ΔI_X depends upon the rate of change of illumination as a function of distance across the retina or the retinal illumination gradient. Image perception, therefore, depends on this gradient.

For every set of viewing conditions there is a threshold difference in cone illumination which will lead to the perception of an image. If cones are exposed to a sub-threshold difference in illumination during their excursions across a projected border, no percept forms. If, as is almost always the case, the retinal illumination gradient of an image border varies from point to point, one perceives a contour wherever the stimulus—that is, the differential illumination of the scanning cones—exceeds the threshold (Fig. 4). Thus, the perceived size and shape of an object may be very different from its true physical characteristics. For

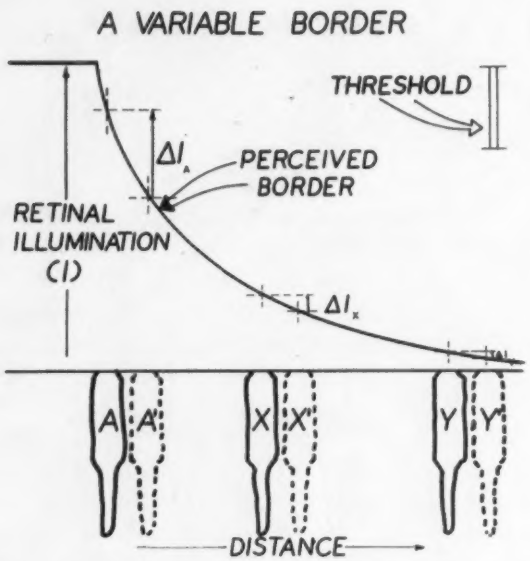


FIG. 4. *The visual threshold and the perception of an image with a variable border illumination gradient.* In the upper right corner the least difference in cone illumination which will result in perception (the threshold) is indicated. Comparison of ΔI_A ΔI_X, and ΔI_Y with this "measuring stick" shows that within the distance through which they move, cone *A* is exposed to an illumination difference slightly greater than the threshold while *X* and *Y* are exposed to illumination differences below the threshold. It is the neural discharge of cone *A*, therefore, which results in the perception of the border. The portion of the image to the right of cone *A* is not perceived.

example, the retinal illumination gradient produced by the image of a nodule is maximal at the periphery of the image, and the physical size of the nodule is accurately perceived. In the case of a pleural effusion, however, the differential illumination of the cones exceeds the threshold at a point remote from the actual periphery of the retinal image, and the effusion, as we perceive it, is always less extensive than it is in fact (Fig. 5).

II

We have said that where cones are exposed to a sub-threshold difference in illumination during their excursions across an image border, no percept forms. To perceive such an image one must increase the stimulus—that is increase the retinal illumination gradient—or lower the threshold, but since we are unable to alter either variable at the retinal level itself, we must relate them to the physical environment which we can control.

The retinal illumination gradient is directly related to the spatial luminance gradient of the film—that is the rate of change of luminance (or brightness) as a

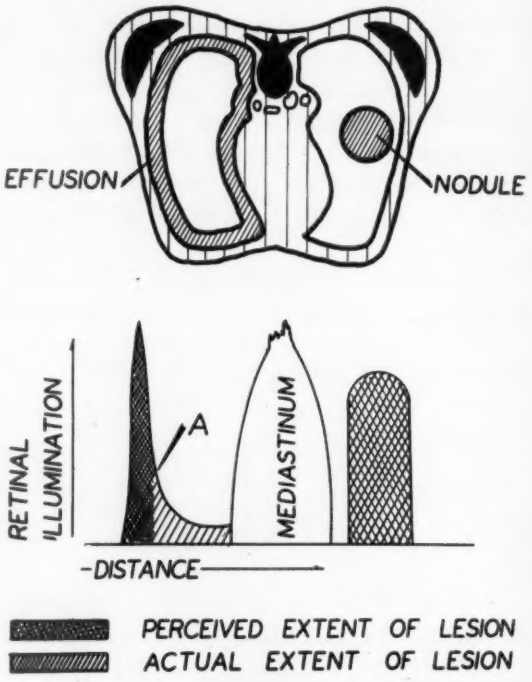
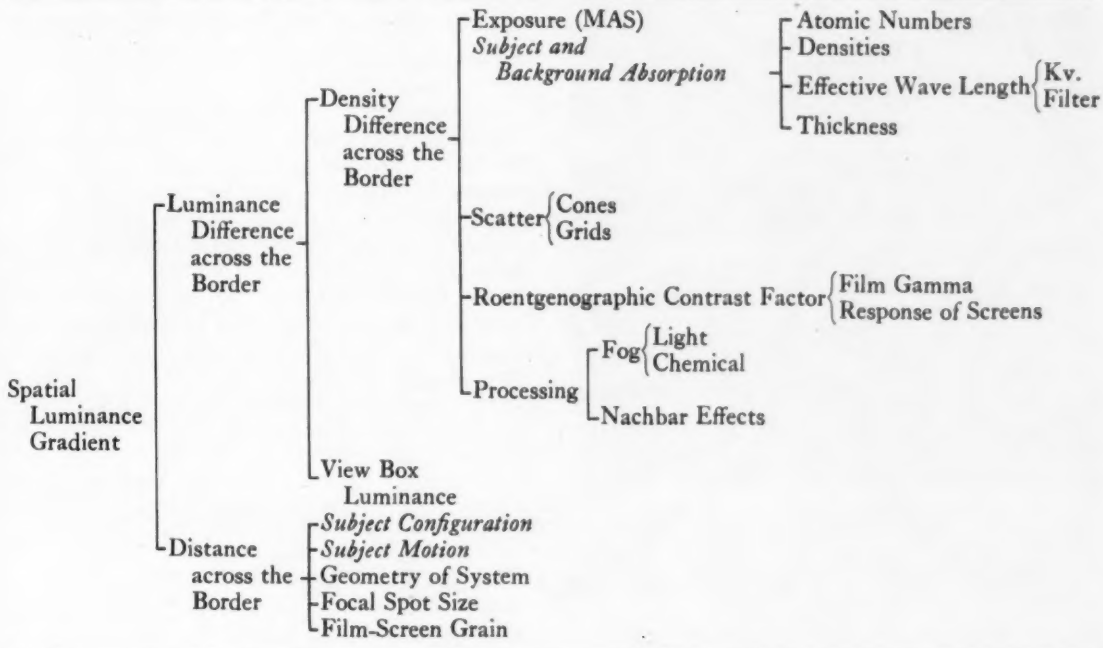


FIG. 5. *An application of the concept of the illumination gradient in roentgen interpretation.* Above, a pleural effusion and a nodule are diagrammatically represented in a cross-section of the human thorax. Below is a graph of the illumination patterns produced by their roentgen images on an observer's retina. Cones scanning the periphery of the image of the nodule are exposed to a supra-threshold difference in illumination and the perceived border, therefore, coincides with the actual extent of the lesion. Similarly, the lateral extent of the effusion is accurately perceived. The medial border of the effusion, however, produces a variable illumination gradient and cones scanning it to the right of *A* are exposed to a sub-threshold difference in illumination. The border is, therefore, perceived at *A*, and the effusion, seen as only a linear density against the lateral chest wall, appears smaller than it is in fact. Actually, the image of an effusion produces a second peak of illumination near the midline but this is usually obscured by the mediastinal shadow.

TABLE I

FACTORS GOVERNING THE SPATIAL LUMINANCE GRADIENT OF A ROENTGEN IMAGE BORDER



function of distance across the roentgenogram. Here "distance"* must be measured in terms of the visual angle subtended at the eye of the observer for only then will it bear a constant relationship to distance on the retina. The factors which control the luminance gradient of the roentgen image are cited in Table 1. They are so familiar that it is of interest here to note only that "subject configuration," though seldom mentioned in the texts, is one of the most important of these factors while "focal spot size" appears to have been emphasized out of all proportion to its true significance.

It is important to note that the retinal illumination gradient depends not only upon the characteristics of the roentgen image itself, but also, upon the reading lens and viewing distance—factors which affect the projection of the roentgen image upon the retina (Fig. 6). Indeed, at the present time, improvement in roentgen diagnosis may, in many cases, be more economically achieved through control of these factors than through modification of the radiologist's equipment or technique. For example, the simple diminishing lens increases the luminance gradient of a threshold soft tissue image so effectively and so economically that we sincerely believe every roentgenogram containing soft tissue detail should be studied with such a lens.† Another example of the value of the reading lens is found in the perception of trabecular detail. Because of the proximity of the individual spicules and the diffusion of their images by the ocular media, their retinal images overlap. The cones, therefore, in their excursions may be subject to a subthreshold illumination difference and the observer is then unable to resolve the trabecular pattern. A *magnifying* lens in-

* Note the distinction between this parameter and "unsharpness" which, expressed in terms of distance measured at the film, bears no constant relationship to distance on the retina (Fig. 6). Since the processes leading to perception are initiated at the retinal level, "unsharpness," as commonly defined, bears no constant relationship to image perceptibility.

† The usefulness of a diminishing lens in roentgen interpretation has been reported in the literature several times in the past. The technique has long been known, but too seldom employed.

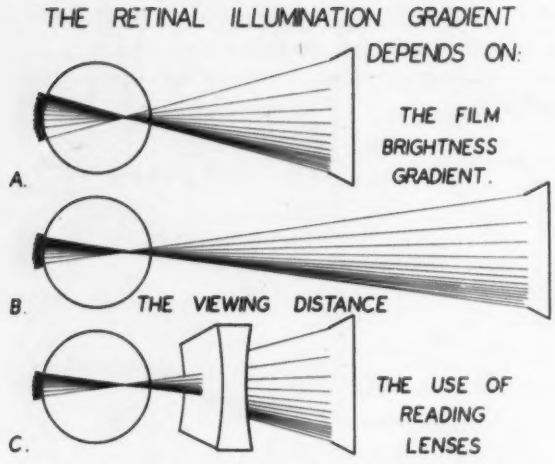


FIG. 6. *The factors determining the retinal illumination gradient.* The projection of a diffuse image border on the human retina is diagrammed in *A*. In *B*, the effect of an increased reading distance is represented. The same border is now projected on half as many receptor cells each of which in moving is exposed to a difference in illumination twice as great as it was in condition *A*. Similarly, *C* demonstrates the role of the diminishing lens in increasing the differential illumination of the cones. By thus increasing the visual stimulus, an increased reading distance or a diminishing lens can make a subliminal image perceptible. Note that the width of the retinal image varies directly as the visual angle subtended by the border, but is unrelated to the width of the border expressed in millimeters at the film.

creases the distance between the elements of the retinal image, prevents their summation, and makes resolution of such details possible (Fig. 7). Note that the reading techniques which increase the percepti-

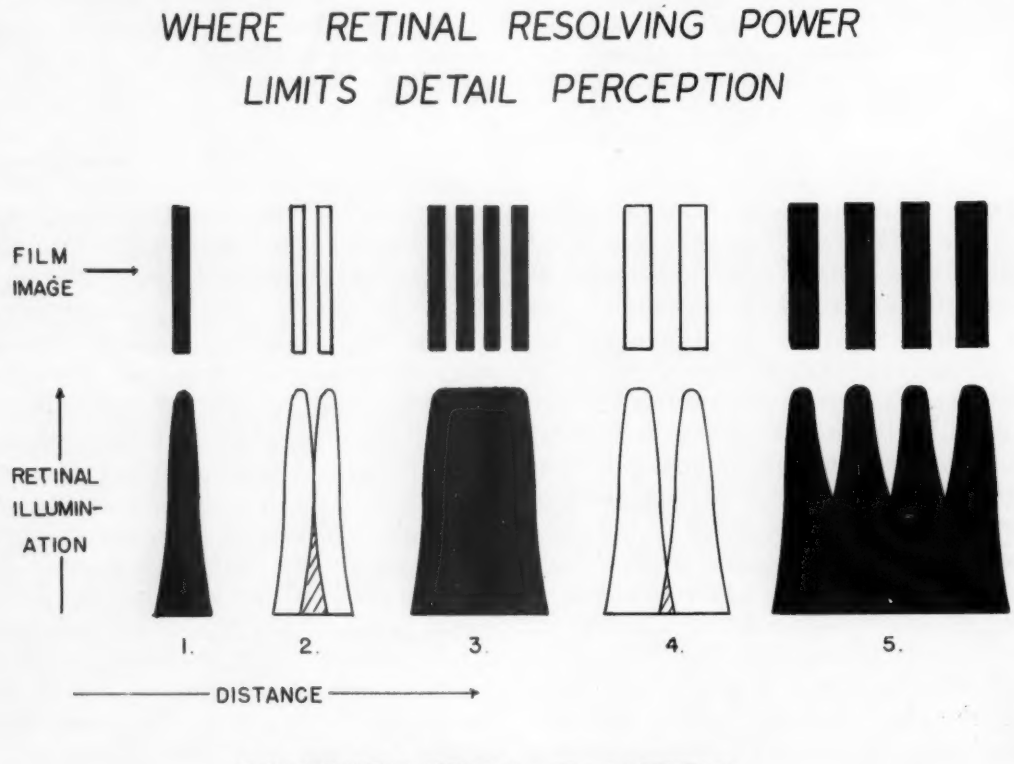


FIG. 7. *The role of magnification in the perception of trabecular detail.* The retinal projection of a roentgenographic detail is always somewhat diffused by the ocular media (1) and the retinal projections of two details in close proximity are likely to overlap (2). The retinal illumination pattern produced by a group of such details is, therefore, a summation of overlapping images, and cones scanning it are exposed to a subthreshold difference in illumination (3). Magnification separates the retinal projections of such details (4). Cones scanning the summated illumination patterns of the magnified images, therefore, are exposed to a difference in illumination exceeding the threshold and the individual details can be resolved (5).

bility of bone detail and soft tissue detail are diametrically opposed. One must, therefore, always specify the nature of an image in considering a problem of perception.

III

The differential illumination threshold of the retina depends, we believe, upon the number of neural discharges contributing to the perception of an image, for the interactions of photons of radiant energy with the retinal cones are random events and obey the laws of probability. The greater the number of such events which are involved in a judgment, the smaller is the increment relative to the background which can be distinguished. The magnitude of the just perceptible difference in illumination, therefore, depends upon the background and total illumination, the fixation time, and the number of cones involved in the judgment.* These factors, too, can be related to the observer's physical environment, and it appears that this threshold can be minimized most effectively by maintaining the adapting luminance of the reader's environment at as high a level as possible without glare.

IV

While the concepts of the retinal illumination gradient and the differential threshold are very useful in explaining the perception of an isolated image, the clinical roentgenogram consists of a multiplicity of images, and many additional factors† probably limit the perception of critical details under these conditions.[8] Indeed, it appears, that the perception of any given image in a roentgenogram is limited by the presence of every other image in the visual field. This concept suggests that the radiologist, like the artist and photographer, can increase the likelihood of one's detecting a significant detail by suppressing noncontributory images. This principle of what might be called "selective roentgenography" appears to merit further exploration. Its value has been proved in laminagraphy and our efforts to exploit it further in supervoltage roentgenography,[12,13,14] though still experimental, are encouraging.

Fig. 8. *A supervoltage roentgenogram.* Bone images have been selectively suppressed. Note the soft tissue detail apparent which cannot be perceived in conventional "high contrast" roentgenograms of the area.

The concept that every image in the visual field limits the perception of every other image is also of importance in the evaluation of roentgenographic techniques. It is clear that the step-wedge and wire mesh cannot simulate all of the effects which limit the perception of a critical image in a diagnostic roentgenogram and the evaluation of a roentgenographic technique in terms of such test objects is, therefore, extremely misleading. For example, supervoltage studies (Fig. 8) are sensitometrically "low contrast" roentgenograms from which it is often inferred that they

* It seems probable that some of the observations of Newell and Garneau[9] on the visibility of repetitive patterns can be explained on the basis of the differential threshold. They state, "Parallel saw-cuts half way through a lucite sheet are more visible than the full thickness outline of the whole sheet." This may be because the effective border length of the saw-cuts is greater and the number of cones involved in the judgment is, therefore, greater.

† We frequently dismiss these as "psychologic effects," attributable to higher centers and quite beyond our control. Actually, many, at least, can be explained at the retinal level[8] in terms of the photochemical equilibria to which we referred earlier.

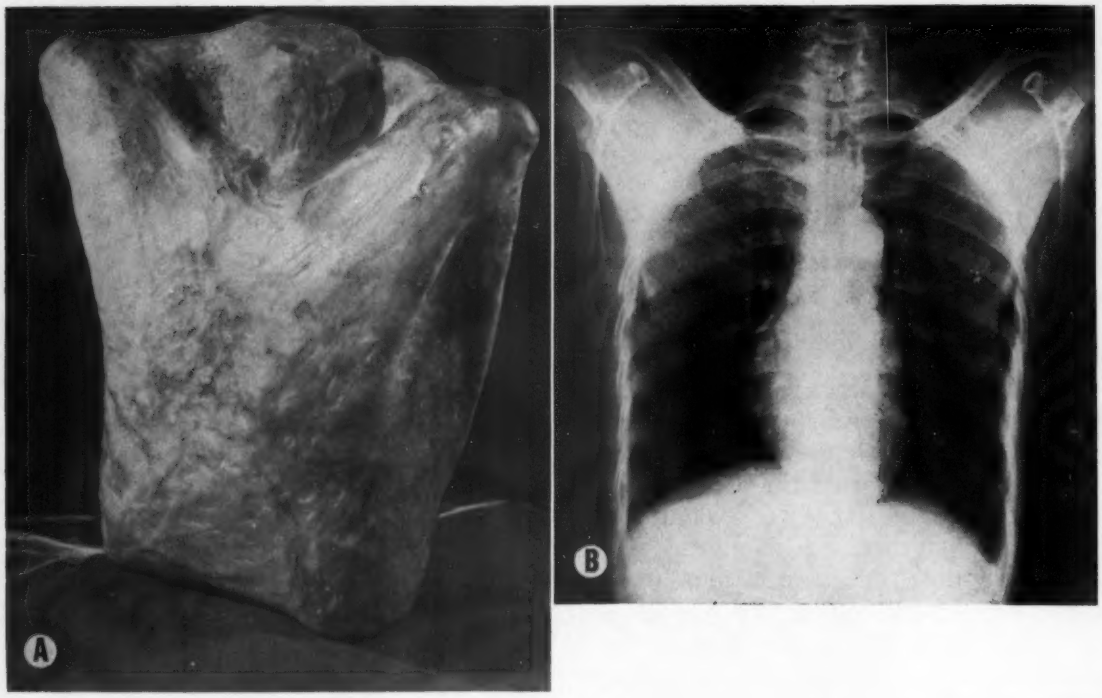


Fig. 9. *The realistic chest phantom of Harris et al.* This phantom permits the evaluation of roentgenographic techniques under realistic but reproducible conditions. (*A*) External appearance of phantom. (*B*) Conventional roentgenogram of phantom.

contain little diagnostic detail. Actually, they demonstrate many details of the respiratory tract better than "high contrast" studies. (We would suggest that for clarity one should specify "bone versus soft tissue contrast" or "soft tissue versus air contrast" when referring to problems of image perception.) Because of this inadequacy of existing methods, we proposed the development of the anatomically realistic phantom which Harris *et al.*[3] have recently described (Fig. 9). Through this medium, we feel that for the first time we can accurately assess roentgen techniques in terms of the relative frequency with which given test objects are perceived under realistic but completely reproducible conditions.

CONCLUSIONS

1. The perception of an image depends fundamentally upon the pattern of illumination projected on the retina and is dependent upon the characteristics of the border of the retinal image, not upon its area.

2. Perception is dependent upon the magnitude of the differential illumination of cones scanning the image border relative to their threshold of response. It bears no constant relationship to either contrast or unsharpness as they are commonly defined.

3. Subliminal images can be perceived if the differential illumination of the cones is increased or the threshold is lowered. The former can be achieved by the use of appropriate reading lenses as well as by meticulous care in roentgenographic technique.

4. The perception of any single image is limited by the presence of all other images in the visual field. At the moment, control of these effects depends upon suppression of insignificant detail through some form of selective roentgenography.

SUMMARY

Image detection, even in a complex visual display such as a roentgenogram, is largely, if not entirely, explicable in terms of the predictable activity of the cones of the central retina. An understanding of their physiology permits us to interpret observed visual phenomena, to define accurately our roentgenographic problems, and to approach rationally the development of improved roentgenologic techniques.

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LOGETRONOGRAPHY*

By ELMER G. ST. JOHN, M.D., *and* DWIN R. CRAIG, B.S.

IT IS well known that considerable information is available in a roentgenogram which can be visualized only by special methods. Detail in a very dense area can be seen with the aid of high intensity illumination. Detail in thin, low contrast areas can be intensified by various chemical and photographic methods. The simultaneous solution to both of these problems is a new method of photographic printing which reproduces detail from both dense and thin areas of the roentgenogram at mid-scale, the most useful portion of the copy film's density range.

This method of printing is called "LogEtronic" because exposure (Log*E*) of a photographic material is not only controlled, but also generated by purely electronic means. LogEtronography, in its application to roentgenography, is intended (a) to simplify the task of making high quality reproductions of roentgenograms for publication, teaching, dissemination, and filing; and (b) to provide the radiologist with a new form of visual and diagnostic aid. Some typical examples are shown in Figures 4 through 12.

The LogEtron is defined as a scanning, servo-modulated light source for use in photographic printing. It provides an automatic means for producing uniform prints from negatives having a random distribution and wide range of density variations. Those familiar with photography will recognize the above as the definition for automatic "dodging," first described by Craig[1,2] as applied to commercial and aerial photography.

In ordinary reproduction, the double emulsion in the roentgenographic film produces an image the density range of which refuses to be compressed to that of a single emulsion without (a) insufferable loss of detail contrast, or (b) total loss of detail in both "highlight" and "shadow" regions. However, with automatic dodging, high contrast detail can be reproduced (even enhanced) in all regions by reducing the highlight, shadow, and mid-tones to a common level. This form of reproduction permits preservation of vital detail information, at the expense of relatively unimportant information concerning gross variations in body thickness, relative radiopacity of bone and soft tissue, etc. The intentional loss of trivial information, in exchange for maximum detail information, represents a bold departure from the notion of "facsimile" or "faithful" reproduction. The results, akin to those secured by photographic masking,[3,4,6,7] are obtained quicker and simpler without registration or tone reversal problems, and for unique identification are called "LogEgrams."

BASIC PRINCIPLE

The LogEtron uses a single cathode ray tube as the printing light source, a pair of stationary photocells to sense the light which passes through the combination of roentgenographic film and printing material, plus two feedback loops through which the photocells control the intensity of the scanning light source and duration of the exposure. The output from photocell #1 is fed back to the cathode ray tube through an A.C. amplifier which performs the dodging operation by instantaneous *intensity* control. That from photocell #2 determines over-all exposure level through *time* control, similar to a phototimer.

Referring to Figure 1, the cathode ray tube, the construction of which is similar to that used in laboratory oscilloscopes, produces a spot of light on a fluorescent screen following bombardment by a beam of electrons. The electron beam, deflected by a pair of triangular waveform voltages,

* From the Department of Radiology, Binghamton City Hospital, Binghamton, New York, and LogEtronics, Inc., Alexandria, Virginia.

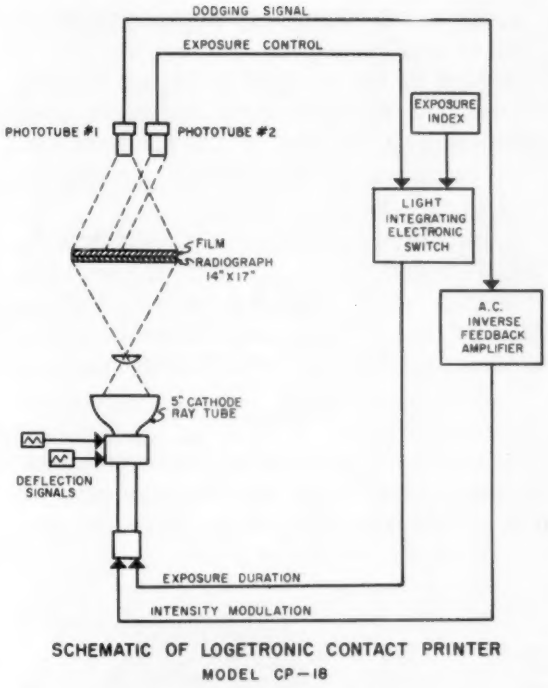

Fig. 1. Schematic drawing of the LogEtronic contact printer. Phototube #1 controls the dodging and phototube #2 controls the over-all exposure. Both feedback loops operate simultaneously and automatically during scanning and exposure of the film.

causes the spot to move about the face of the tube so as to scan a rectangular area. Light from this scanning spot is projected by a simple lens through the roentgenographic film, where it exposes the printing paper or film. Light penetrating the combination is partially collected by the photocells. Photocell #1 "views" the entire field, while photocell #2 "views" only a selected portion.

Signals from photocell #1 in the dodging channel correspond to density variation in the roentgenogram and are used to modulate electron beam intensity, and thus modulate light output of the cathode ray tube. Signal polarity is arranged to produce inverse feedback, so that when a dense region of the roentgenogram is being scanned, the spot instantaneously becomes brighter, going dimmer for thin regions. As a result, an unsharp, *negative* luminous image of the roentgenogram is formed at the face of the cathode ray tube, and then projected back through the *positive* roentgenogram. The superposition produces a uniform distribution of light over the printing area, giving a uniformly exposed print regardless of wide density variations in the roentgenograms. The amount of feedback may be varied to achieve results ranging from a facsimile reproduction up to one having an over-all gray tone accompanied by extremely high detail contrast.

Photocell #2 views only that portion of the field which is manually selected as the center of interest. This area, 2 inches in diameter, is then automatically reproduced at mid-scale of the printing material's density range, with other areas being exposed above and below this level depending on the residual density variations remaining after dodging.

The feedback channel from photocell #2 contains an integrating circuit which continuously totalizes the light passing through the selected area. After sufficient time has elapsed for the integrated light to reach the preset level (determined by emulsion speed and subsequent processing), an electronic switch automatically terminates the exposure. Although exposure times may vary from one roentgenogram to the next, exposure levels of the selected area will be constant since only that light which reaches the emulsion contributes to the integral. Since the integrated area is fixed, no adjustments are necessary for different sizes or average densities of roentgenograms.

SCANNING PATTERN

The chief requirement of the scanning pattern is to provide uniform coverage of the area being printed. The pattern is generated by a pair of triangular waves of slightly different frequencies. The easiest mental picture to form of the ensuing spot motion is that of a billiard ball striking a cushion at slightly less than 45 degrees and proceeding from there *ad infinitum*. With this type of pattern the spot spends equal times at all positions and, with gen-

erous overlap, yields an exposure without trace of scanning lines.

OPTICS

On a cathode ray tube 5 inches in diameter, the scanning pattern covers only 3 by 4 inches and must be projected up to a 14 by 17 inch area in order to cover a large roentgenogram. A simple lens with an f/1 aperture is adequate, since quality of the projected spot has no influence on resolution of detail. When projecting to 14 by 17 inches, the scanning spot is approximately 1/2 inch in diameter. When printing smaller sizes, a different lens can be used to obtain a scanning spot as small as 1/16 inch in diameter, giving better "dodging resolution" (independent exposure of smaller areas).

Optics of the printing stage are conventional, the roentgenogram resting on glass with the paper or film held in intimate contact by a transparent plastic air bag attached to a latching platen.

Light for photocell #1 is collected by diffuse transmission through the printing material, while that for photocell #2 is directed from a lens and movable mirror combination through a restricting aperture.

SPOT SIZE

If the spot were infinitely small, the final exposure would be a uniform gray expanse completely devoid of image. However, the

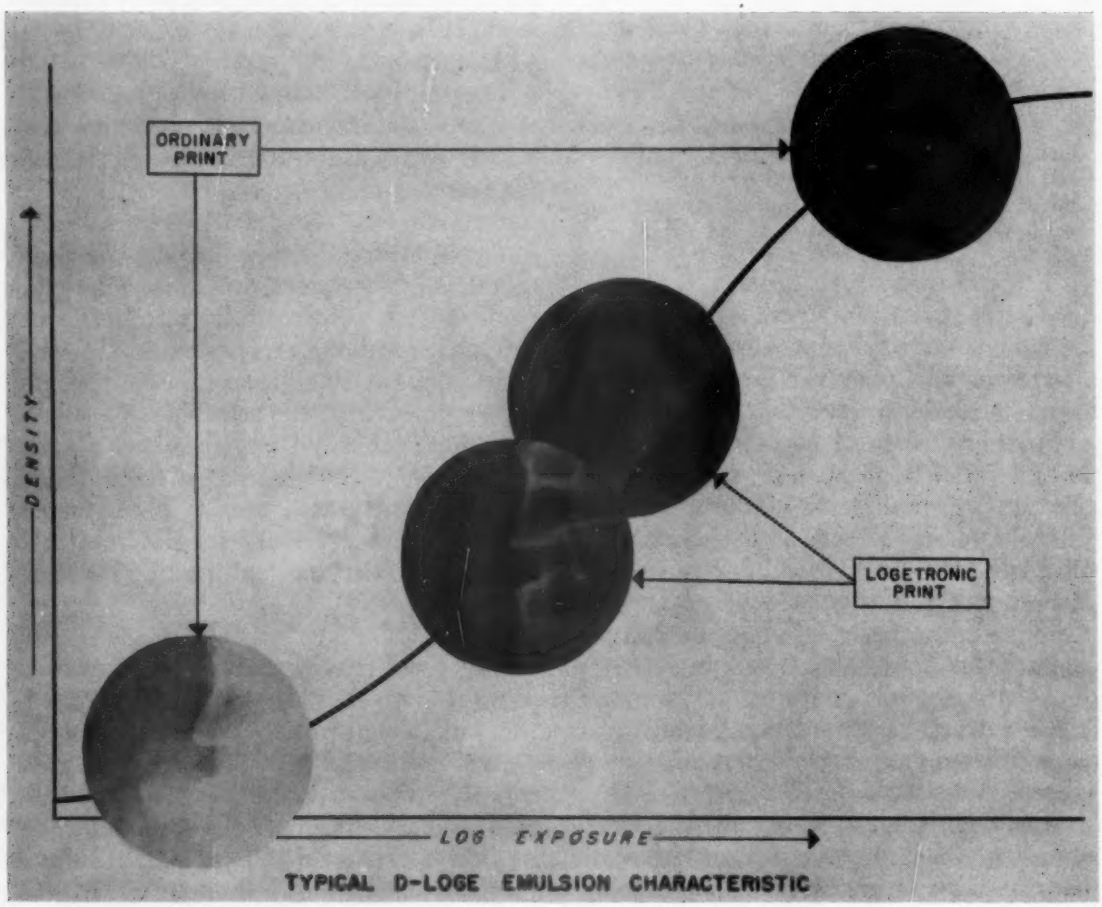

FIG. 2. The lower left section (underexposed) and the upper right section (overexposed) were taken both from an ordinary print of a roentgenogram. The two center sections, taken from a LogEgram made from the same roentgenogram, show a reduction of contrast *between* the sections plus greater detail contrast *within* the sections.

spot (being finite) is sufficiently large in the printing plane to avoid this effect. Spot diameter (approximately 1/2 inch when printing 14 by 17 inches) is large compared to most detail in the roentgenogram, but small compared to total frame size. This provides good dodging resolution, allowing both "shadow" and "highlight" areas to be exposed independently, bringing out maximum detail in each.

PHOTOGRAPHIC EFFECT

Paradoxically, the photographic effect of dodging is to decrease and to increase contrast simultaneously. *Gross contrast decreases* while *detail contrast increases*. This is best illustrated in Figure 2, which shows the response of a typical photographic emulsion to light—a plot of resulting density versus logarithm of the exposure, or its *D*-Log*E* characteristic.

In an ordinary print, highlight and shadow regions within a roentgenogram would be printed at opposite extremes of the density scale, where the slope of the curve is flat (low contrast) and detail merges with its background. However, these same two regions in a LogEtronic print are reproduced near mid-scale where the curve is steep (high contrast). Hence, by bringing the two regions closer together in average density, gross contrast is reduced while detail contrast is maximized, resulting in better visualization throughout.

OPERATION

Operation of the LogEtronic Contact Printer (Fig. 13) is relatively simple, since both dodging and exposure control are automatic.

First, an intermediate transparency is made on single emulsion film from the

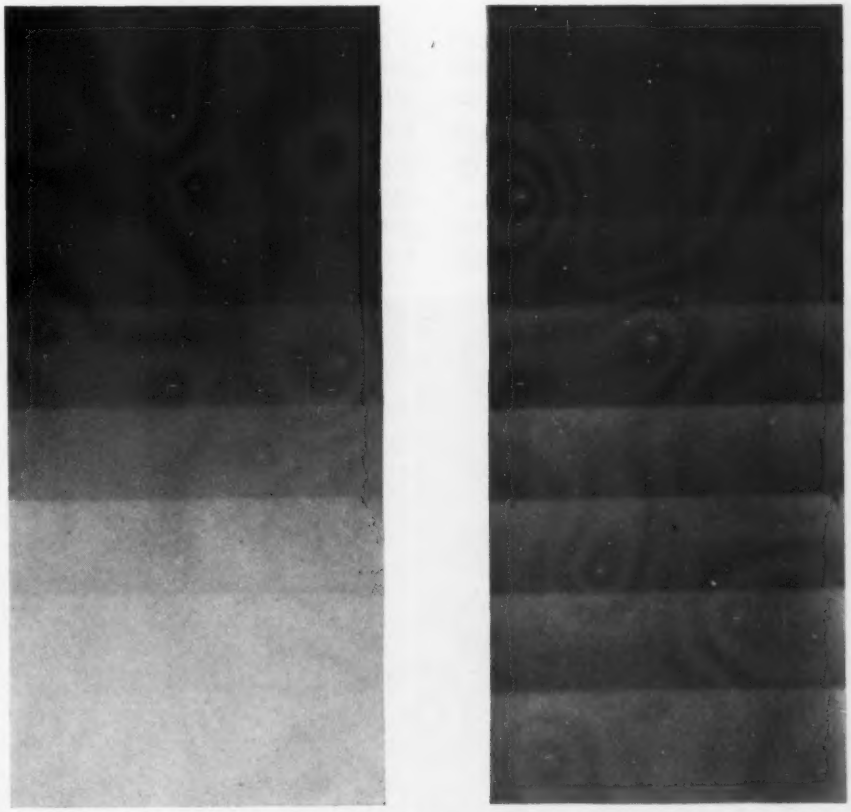

Fig. 3. Roentgenogram of aluminum step-wedge. The roentgenogram on the left was obtained utilizing ordinary roentgenographic technique and then reproduced with the LogEtronic printer (right). Note the over-all decrease in densities, plus enhancement of density differences at boundaries. More steps can be seen and the boundaries are more prominent—indicating a general increase in detail content.

Fig. 4. Posteroanterior roentgenogram of the chest taken at a physician's private office. On the right is a LogEgram made from the original film shown at the left. The left parenchymal lesion is a bronchial adenoma.

original roentgenographic film, exposed in the printer, and processed in standard solutions. Then, by the same procedure, a final on paper or film is made from the intermediate.

In both exposing steps the operator selects the center of interest of the roentgenogram, inserts the printing material, sets the precalibrated *exposure index dial* for emulsion speed of the printing material, lowers the platen, which starts the exposure, and waits (10–60 seconds) until the *printing* light indicates automatic termination of the exposure. Roentgeno-

Fig. 5. Left lateral view of Figure 4. The LogEgram on the right shows the breast, the nipple shadow and the tortuous vessels in the anterior abdominal wall, which cannot be seen in the conventional reproduction on the left.

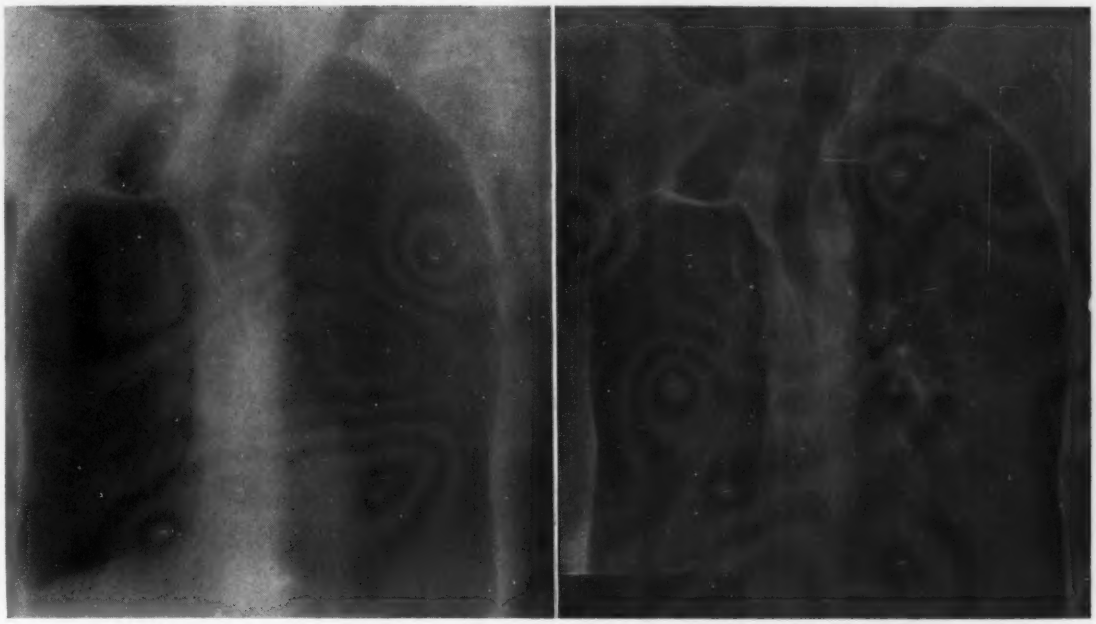

Fig. 6. Posteroanterior chest roentgenogram made with 1,000 kv. technique. On the right is shown the LogEgram obtained with full dodging during exposure, and extreme contrast build-up during processing.

grams from 8 by 10 inches to 14 by 17 inches or sections down to 4 by 5 inches may be printed without recalibration. The exposed material is then processed in accordance with the standard procedure which produces the desired detail contrast for the subject and/or ultimate use of the reproduction.

VARIATIONS

Although the usual end-product from the LogEtronic contact printer is at the same scale as the original, existence of the intermediate transparency permits numerous variations in the final step in terms of scale and materials. For example, a reduced copy of the intermediate on glass, paper, or film can be made in one step with conventional equipment, for slide projections, microfilming, medical display, or economical large-scale dissemination—all benefiting from improvement in the intermediate.

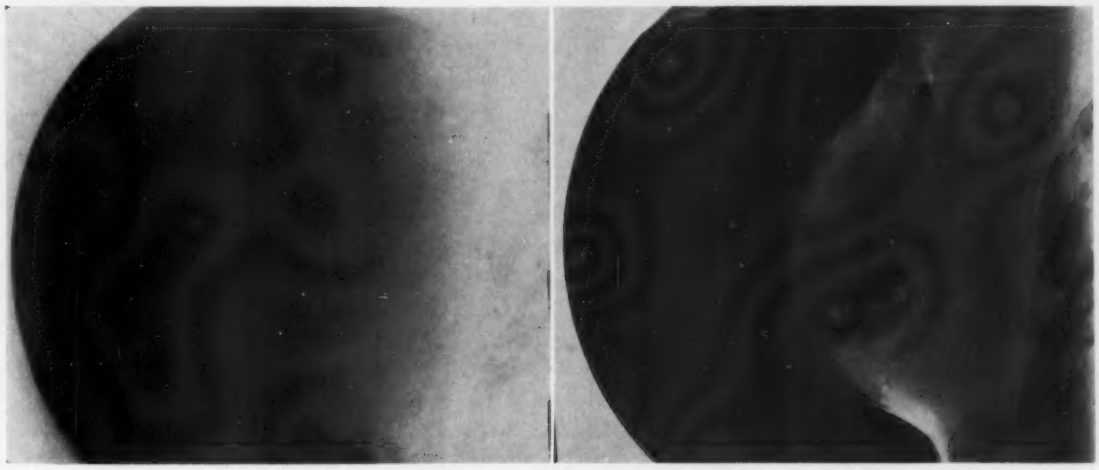

Fig. 7. Left: Soft-tissue roentgenogram of a normal breast. Right: LogEgram from this film shows vast improvement in detail.

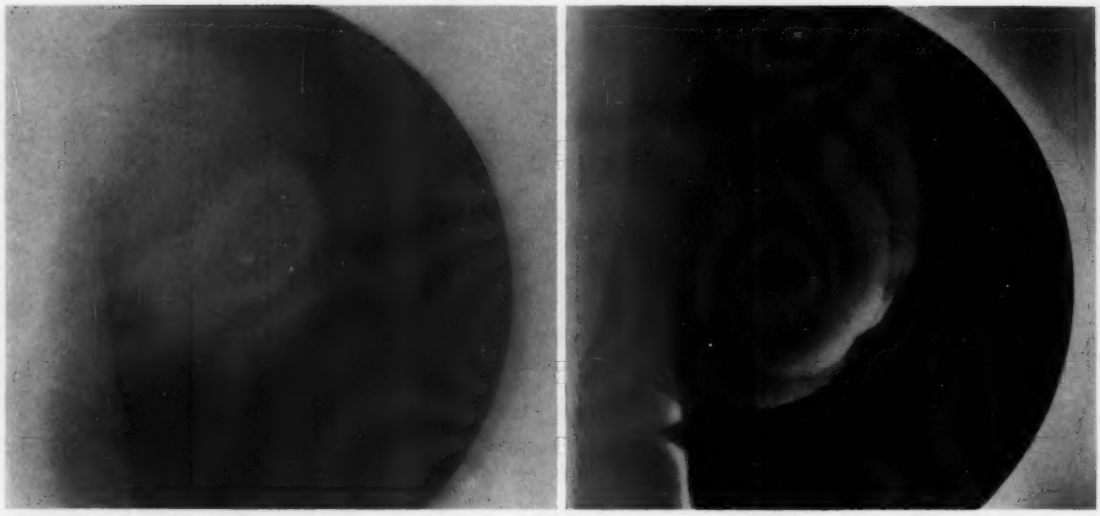

FIG. 8. Left: Soft-tissue roentgenogram showing a bilobed benign cyst of the breast. Right: The cyst is demonstrated with more clarity. Shown also is the presence of soft-tissue structures about the cyst.

PRELIMINARY WORK

A LogEtronic printer, designed for aerial photography, was operated at Binghamton City Hospital for a period of approximately five months in an effort to obtain real evidence of its ability to provide the radiologist with diagnostic information not available in a routine roentgenogram. LogEgrams were made from approximately 500 films representing both current cases and material from the files. As outlined in a preliminary report by St. John,[5] it was found that the resultant LogEgrams clarified the diagnosis in many of the cases under investigation.

Following this work, equipment was redesigned to handle the extreme density ranges and larger sizes unique to roent-

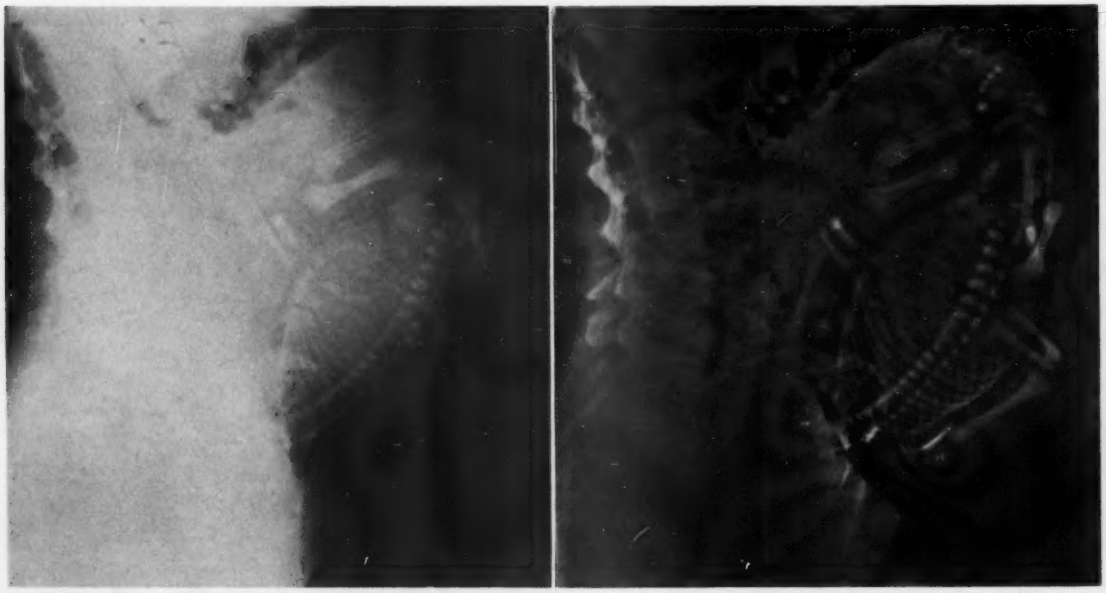

FIG. 9. Placentography: Detail in reference to placental implantation is poor in the roentgneogram at the left. The LogEgram at the right shows definite implantation of the placenta upon the posterior-superior uterine wall.

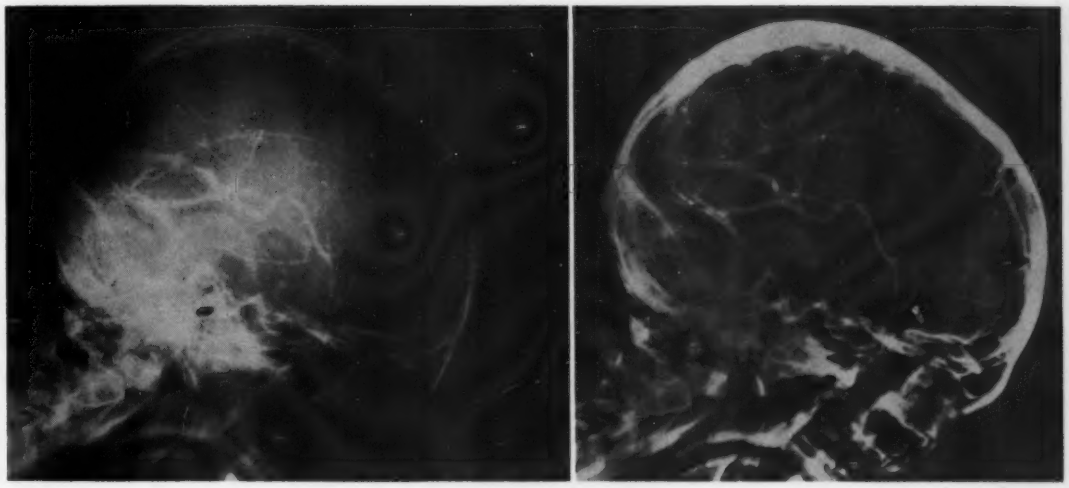

Fig. 10. Cerebral venogram: Showing better visualization of the vessels in the LogEgram at right.

genography, with added emphasis on reliability and a higher degree of automation. Processing techniques were simplified through the choice of printing materials which allow use of standard roentgenographic solutions and processing times.

Transparencies were made with the new equipment and techniques. The illustrations for this article were prepared from these transparencies for half-tone reproduction by a commercial photographer, with instructions to give identical treatment to both the original and the LogEgram. The striking difference in Figures 3 through 12 therefore represents what may actually be seen on an illuminator.

CONCLUSION

The simplicity in producing LogEgrams for publication will be evident to those acquainted with the high degree of automation made possible through modern electronics. The need for simplicity will be appreciated only by those familiar with other techniques. However, the quality of the accompanying illustrations may be judged by all.

As a diagnostic aid, it is generally ob-

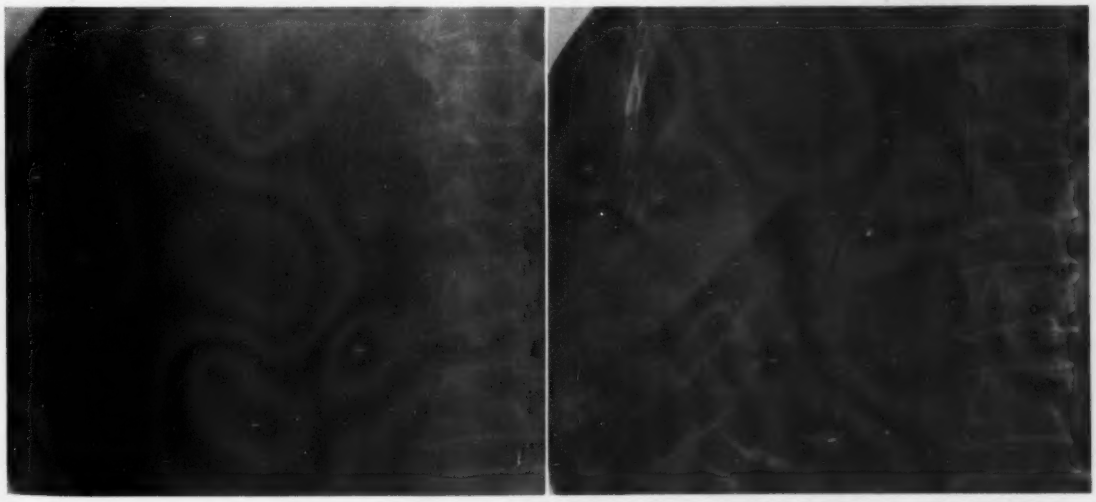

Fig. 11. Intravenous cholecystogram: Radiolucent calculus in the common bile duct near or at the ampulla of Vater. Cholografin has entered the intestinal tract. The cholografin coated intestinal tract is clearly seen in the LogEgram on the right.

Fig. 12. Anteroposterior view of the abdomen containing a full term fetus.

Fig. 13. Photograph of the LogEtronic Model CP-18 contact printer with which the LogEgrams for this article were made.

served that more detail is readily available from the LogEgram than from the original roentgenogram. From the numerous cases reproduced, it was found that technically inferior originals could yield diagnostic LogEgrams—a valuable tool when it is impossible, or difficult, to recall the patient for repetition of the roentgenographic examination.

It is believed that LogEgrams will also prove useful for teaching and for legal purposes and, at small scale on paper or film, for filing systems or for direct attachment to patients' records.

The imaginative reader will undoubtedly envision many other potential applications of the basic principles described here, a number of which will be the subject of future publications.

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We are indebted to Col. Elmer A. Lodmell, of Walter Reed Army Hospital, Washington, D. C., for the loan of the million volt chest roentgenogram, and to the Ansco Division of General Aniline & Film Corporation, Binghamton, New York, for the step-wedge pattern.

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AN EMERGENCY CART FOR THE RADIOLOGIC DEPARTMENT*

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SINCE emergencies frequently arise in a radiologic department requiring the availability of certain drugs and specialized equipment, it was found desirable to develop an emergency cart which would hold those items essential for immediate treatment.

Prior to the use of the cart, oxygen tanks, a suction apparatus, syringes and certain instruments and drugs were kept stored in various cabinets and closets in the department. In spite of frequent checks, it was our experience that the drug or instrument desired might be difficult to locate when needed.

Stimulated by the recent publication by Pendergrass, Hodes, Tondreau, Powell and Burdick[2] concerning the incidence of deaths and severe reactions following the parenteral use of iodine-containing compounds in excretory urography, consultations were held with other staff members in the fields of allergy, pharmacology, anesthesiology, general medicine, thoracic surgery and neurosurgery and a collection of stimulant and supportive drugs and of basic equipment was developed (Table 1). Each item was clearly labeled as required. A standard Picker stainless steel utility cart was altered somewhat by adding side panels and by cutting an opening in the top for an oxygen tank.

The cart is kept in the corridor of the radiologic department within easy access of any of the rooms where such procedures as excretory urography, bronchography, angiocardiography, cerebral angiography, pneumoencephalography, etc., are performed. When examinations are being made of seriously ill or traumatized patients (particularly those with oxygen deficit or with obstruction of the respiratory tract from hemorrhage, excessive secretions or other cause), the cart is kept in the room with the patient where the suction machine and oxygen apparatus are at hand for immediate use.

All personnel in the department—radiologists, residents and technicians—are briefed on the contents of the truck and the operation of each item of equipment. The physician members of the department are familiarized with the types of reactions which might be anticipated and the recom-

FIG. 1. Emergency cart with drugs and more commonly used instruments, etc., on top shelf, suction apparatus and infusion equipment on lower shelf, miscellaneous items on middle shelf

* From the Division of Radiology, University of Vermont College of Medicine and Mary Fletcher Hospital, Burlington, Vermont

TABLE I

CHECK LIST OF CONTENTS OF EMERGENCY CART

Drugs	Equipment
Adrenalin (epinephrine) 1:1000	Alcohol sponges
Aminophylline 0.5 gm., 20 cc. ampules	Endotracheal catheters, sizes 2, 4, 6, 8 and 10, with connectors
Amyl nitrite in glass pearls, 3 minims	Laryngoscope and blade
Aromatic spirits of ammonia	Lubafax
Atropine sulfate, 10 cc. vial, 0.6 mg./cc.	Nasal catheters
Benadryl, 10 cc. vial, 10 mg./cc.	Oral airways
Caffeine sodium benzoate, 2 cc. ampules, 0.5 gm.	Oxygen tank, gauge, tubing, bag and masks (adult and child) and retainer
Calcium chloride, 10 cc. ampules, 1 gm.	Sphygmomanometer and stethoscope
Cedilanid D, 4 cc. ampules, 0.8 mg.	Sterile gloves
Ephedrine sulfate, 1 cc. ampules, 0.05 gm.	Sterile needles, No. 15, 16, 18, 20 and 25
Glucose, 5 per cent in water; 2 1000 cc. bottles with infusion apparatus	Sterile scalpels with blades in jar
Hydrocortisone sodium succinate (Solu-Cortef), 100 mg. ampules	Sterile scissors and scalpel blades
Levophed, 0.2 per cent, 4 cc. ampules	Sterile tray for cardiac massage and cut down
Neosynephrine hydrochloride, 1 per cent, with bottle of sterile distilled water	Suction apparatus
Pentothal sodium, 1 gm. with bottle of sterile distilled water	Sterile syringes, 2, 5, 10 and 20 cc.
Potassium chloride, 18.8 meq/10 cc.	Tongue depressors
	Tourniquet

mended therapeutic measures for each. A check-list of drugs and equipment is kept on the truck, and it is the assigned duty of one of the technicians to check the contents of the truck against the list each day.

The suggestions of Pendergrass and his associates regarding prophylaxis and treatment of reactions have been followed with a few minor modifications. Before any procedure involving the intravenous administration of an iodine-containing compound is undertaken, a careful history is taken concerning previous allergic manifestations or sensitivity to certain drugs, especially those containing iodine; a strong allergic history, especially when combined with a positive sensitivity test, offers a strong argument against continuing with the procedure.

It must be admitted that preliminary intracutaneous, lingual and conjunctival tests have proved of little value in detecting drug sensitivity, but a positive reaction is helpful. It has seemed advisable to perform one or more tests on the chance that a positive reactor might be identified as well as for medicolegal protection.

It is our current practice to administer an antihistaminic drug—usually chlorprophenpyridamine maleate (chlor-trimeton)—intramuscularly about one-half hour prior to the injection of the contrast medium. Five mg. is the average adult dose.

At the time of administration of the contrast medium, a drop or two is injected intravenously and the needle held in place for one minute. If no untoward symptoms develop, an additional 0.5 cc. is then injected. After a second waiting period of one minute, 1.0 cc. is injected. After a third waiting period of one minute if no reaction has taken place, the remainder of the drug is administered, either rapidly or slowly, depending on the procedure involved.

It is apparently a fact, however, that, even in the absence of a suggestive history or a reaction to the preliminary tests, and in spite of the use of antihistaminic agents, there is still a small but definite risk to any type of procedure involving the intravenous or intra-arterial injection of iodine-containing drugs.

During the first six months of operation, the most commonly used items on the cart

were aromatic spirits of ammonia, atropine, diphenhydramine hydrochloride (benadryl) chlorprophenpyridamine maleate (chlortrimeton), oyxgen and suction. Fortunately we have not been faced with the necessity of using a tracheotomy or thoracotomy set, but with the benefit of training received from the surgeons, we feel that in the event of a dire emergency we could use either if a surgeon could not be located immediately. The "cut-down" set for open exposure of veins and the laryngoscope and intubation set have been used occasionally, the latter usually by an anesthesiologist, laryngologist or thoracic surgeon.

The value of atropine sulphate in the treatment of neurocirculatory collapse, particularly with vagal effect, should be emphasized. In our experience, it has been a most useful agent in the treatment of the type of reaction which is seen in apprehensive or emotionally distressed patients who may lapse into a state of hypotension with pallor, sweating, weakness and slow, thready pulse. While most respond promptly to the intravenous injection of 0.4 to 0.8 mg. of atropine sulphate, we have had no hesitation in administering a second dose in a few minutes, if indicated.

Atropine is also used prophylactically before such procedures as pneumoencephalography, ventriculography and cerebral angiography.

Contrary to common belief, there is a wide margin of safety in the dosage of atropine. It is estimated that the usual fatal dose for adults is approximately 100 mg. and for young children about 10 mg., but in at least one recorded case 500 mg. was administered to a patient with complete recovery.[1]

Neo-synephrine and l-nor-epinephrine (levophed) in 5 per cent glucose are available for use in cases of profound hypotension; hydrocortisone sodium succinate is also on hand for use in the event that a severe allergic reaction does not respond to antihistaminic drugs or adrenalin.

CONCLUSION

To be prepared to meet such emergencies as may arise in a radiologic department, it is essential that (1) an emergency cart be available and that the contents of the cart be checked daily by a responsible person with scrupulous attention to details; (2) replacements be made immediately after use of any item; (3) there be in attendance at all times during the performance of procedures involving the intravenous and intra-arterial use of iodine-containing drugs a physician familiar with possible reactions and their treatment; (4) there be frequent re-evaluation by the radiologist and his colleagues of the problem of management of emergencies arising in the radiologic department to cope with them effectively as they arise and to prevent them from occurring, if possible.

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STUDIES OF THE TISSUE DISTRIBUTION AND EXCRETION OF SODIUM DIATRIZOATE IN LABORATORY ANIMALS*

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THE preparation of sodium diatrizoate,‡ a new urographic contrast medium, was reported,[5] and the first clinical trials were made in 1954. The compound contains 60 per cent iodine, to provide radiopacity, and is of remarkably low intravenous toxicity.[3] Roentgenographic and biochemical studies of the excretion properties of this substance in experimental animals demonstrated that it is rapidly eliminated, almost exclusively through the kidneys, in sufficient concentration to provide excellent delineation of the morphology of the urinary tract. This finding of uniformly low systemic toxicity and excellent urographic visualization in experimental animals appears to correlate well with clinical studies, wherein a high percentage of superior urograms, along with a low incidence of (rather minor) side-effects, has been observed.[2,4,6,10–14]

In view of the aforementioned fact that the excretion of sodium diatrizoate appeared to take place through the kidneys, with little or no excretion in the bile, it became of interest to investigate its tissue distribution and the mechanism and rate of its excretion, following intravenous administration. It is the purpose of the present communication, therefore, to present the results of such studies, which have been carried out in the cat and dog. Similar data on sodium acetrizoate, iodopyracet,§ and sodium iodomethamate have been obtained for comparative purposes and are included in the tables.

‡ Marketed by Winthrop Laboratories under the brand name of Hypaque Sodium.

§ Marketed by Winthrop Laboratories under the brand name of Diodrast.

EXPERIMENTAL METHODS AND RESULTS

A. *Excretion of Sodium Diatrizoate by Dogs.* Four healthy adult mongrel dogs weighing 10–13 kg. were fasted overnight, and were then given intravenously 2 ml./kg. of a 50 per cent solution of sodium diatrizoate. The animals were kept in metabolism cages for 72 hours thereafter; they were catheterized at the end of 2, 4, and 6 hours, and urine was collected in the cages for the periods 6–24, 24–48, and 48–72 hours. Feces were collected for 0–24, 24–48, and 48–72 hours. The excreta were analyzed for organic iodine by the method of Zak and Boyle,[15] and the corresponding content of diatrizoate was calculated (for results, see Table 1). The data indicate that the compound is excreted in the urine at much the same rate by each animal, with about two-thirds of the contrast medium being eliminated in the first 2 hours. Excretion during the next 4 hours continues to be very rapid, so that 88 per cent of the dose has been excreted in 6 hours. Thereafter, excretion is at a considerably slower rate. Comparable published data[8] on sodium acetrizoate indicate that dogs receiving intravenous doses of 0.5 gm./kg. (half the dose level of diatrizoate used in these experiments) excrete 57 per cent of the dose in 3 hours, and 65 per cent in 5 hours.¶

Assuming normal renal function in both of the sets of experimental animals, the urinary excretion rate of acetrizoate would be estimated as about 80 per cent of that

¶ Neuhaus, Christman and Lewis[7] found that rabbits excrete 65.7 per cent of acetrizoate, 42 per cent of iodopyracet, and 49.7 per cent of iodomethamate in 6 hours, at a dose level of 500 mg. per rabbit. Most of this excretion, however, was actually completed in 3 hours.

* From the Sterling-Winthrop Research Institute.
† With the technical assistance of John P. McAuliff, William F. Banks, Jr., and John P. Romano.

TABLE I

EXCRETION OF SODIUM DIATRIZOATE BY DOGS FOLLOWING THE INTRAVENOUS ADMINISTRATION OF A DOSE OF 1 GM./KG.*

Time after Administration hours	Urinary Excretion				
	Dog No. 14857	Dog No. 14869	Dog No. 14871	Dog No. 14873	Mean ± s.e.
0–2	65.1	68.0	67.3	66.7	66.5±0.9
2–4	12.3	16.5	17.3	8.9	13.7±2.0
4–6	5.6	7.1	12.0	5.0	7.7±1.6
6–24	7.0	2.1	‡	6.2	3.8±1.9
24–48	†	1.6	6.8	0.5	3.0±2.0
48–72	†	0.2	‡	0.2	0.1±0.1
0–72 total	90.0	95.5	103.4	87.5	94.8±3.5
	Fecal Excretion				
0–24	2.1	0	‡	0.6	0.7±0.5
24–48	1.0	0.7	0	1.4	0.8±0.3
48–72	†	0.6	0.8	0.5	0.6±0.1
0–72 total	3.1	1.3	0.8	2.5	2.1±0.5

* Data are given in terms of per cent of dose.
† No excreta were collected during these periods.
‡ There was no elimination during these periods. The urinary excretion in dog 14871 for 24–48 hours was undoubtedly formed mostly during the 6–24 hour period.

of diatrizoate. The fecal excretion of diatrizoate averages about 2 per cent of the dose; comparable data on acetrizoate do not appear to be available.

B. *Isolation of the Excretory Product.* When the urine samples (for the first 6 hours after medication) from the dogs receiving diatrizoate were acidified to pH 2 with hydrochloric acid, a heavy crystalline precipitate formed.* It was washed with cold water, dissolved in dilute ammonium hydroxide, and the solution was decolorized by treatment with activated charcoal. Dilute hydrochloric acid was added to the point of incipient crystallization, after which the solution was allowed to stand at room temperature for several hours. The crystals that formed were collected on a suction filter, washed with cold water, and dried at 100°C. Since the melting point of diatrizoic acid is not especially distinctive, the crystals were identified by analysis for their organic iodine content and alkali combining capacity (neutral equivalent). Found: iodine content, 58.9 per cent; neutral equivalent, 596. Calculated for diatrizoic acid, 62.0 per cent iodine; neutral equivalent, 614. This demonstrates, as expected, that diatrizoate is excreted in the urine unchanged, since the above values differ from the calculated amounts by less than 5 per cent.

C. *Tissue Distribution and Excretion in the Cat.* Healthy adult cats weighing about 2 kg. were starved overnight, but were allowed water *ad lib.* In the morning they received intravenously 1 ml./kg. of a 50 per cent solution of sodium diatrizoate, or of other urographic agents as identified in Table II. At various time intervals thereafter the cats were deeply anesthetized with nembutal (32 mg./kg., i.p.), a sample of blood (10 ml./kg.) was drawn by cardiac puncture, after which the animals were sacrificed. The urinary bladder was tied off and removed; other items taken for analy-

* The precipitation of diatrizoate by strong acids will lead to false positives in qualitative tests for urinary proteins, if a distinction is not made between the crystalline diatrizoic acid precipitate and the flocculent protein precipitate. It is recommended, therefore, that the acetic acid-heat coagulation test be used for detecting the presence of proteins in urine containing diatrizoate, since this test does not give false positives.

TABLE II

TISSUE DISTRIBUTION AND EXCRETION OF SOME PYELOGRAPHIC AGENTS IN CATS AFTER THE INTRAVENOUS ADMINISTRATION OF A DOSE OF 500 MG./KG.
ALL FIGURES ARE IN TERMS OF PER CENT OF DOSE

Compound Administered	Time after Administration hours	Materials Analyzed												
		A. Urine	B. Kidney	C. Liver and Bile	D. Digestive Tract	E. Spleen	F. Lung	G. Heart	H. Muscle*	I. Plasma†	J. R.B.C.†	K. Total A-J	L. Other	M. Total A-L
Sodium diatrizoate	0.5	45.6	2.5	5.7	3.2	0.05	0.8	0.2	8.3	11.4	0.7	78.4		
Sodium diatrizoate	0.5	37.6	2.1	5.7	4.2	0.10	0.6	0.2	9.0	10.6	0.4	70.5	1.6‡	72.1
Sodium diatrizoate	1	40.5	2.3	6.9	3.4	0.0	0.6	0.10	16.5	9.1	0.2	79.6	3.9§	83.5
Sodium diatrizoate	1	52.5	3.8	3.5	4.7	0.10	0.5	0.10	6.7	6.2	0.4	78.5	7.0¶	85.5
Sodium diatrizoate	3	85.8	0.7	3.9	3.5	0.04	0.2	0.06	0	1.8	0.1	96.1		
Sodium diatrizoate	3	79.2	0.8	5.1	3.5	0.02	0.15	0.03	2.6	2.2	0.1	93.8		
Sodium acetrizoate	3	48.4	1.7	7.9	3.9	0.06	0.4	0.16	13.5	7.2	0.4	83.6		
Sodium acetrizoate	3	72.0	1.3	2.3	6.7	0.07	0.3	0.08	4.0	3.8	0.4	90.9		
Iodopyracet	3	72.0	1.6	2.1	7.1	0.01	0.10	0.04	6.0	2.0	0.6	91.6		
Iodopyracet	3	60.8	2.1	5.3	6.2	0.03	0.3	0.10	12.5	3.5	0.5	91.3		
Sodium iodomethamate	3	80.0	1.8	1.3	2.2	0.03	0.3	0.08	2.4	2.9	0.1	91.1		
Sodium iodomethamate	3	83.4	1.4	1.2	1.8	0.04	0.4	0.07	3.0	3.1	0.1	94.5		
Sodium diatrizoate	5	91.0	0.3	2.1	1.3	0.01	0.07	0.01	0	1.3	0.1	95.0		
Sodium diatrizoate	5	93.0	0.5	2.3	1.5	0.01	0.07	0.02	1.2	1.2	0.04	99.8		

* Total weight of muscle was estimated as 45 per cent of body weight.

† Blood volume estimated as 75 cc. per kg. body weight. Plasma/cell distribution determined by hematocrit method.

‡ Pregnant female cat. This amount was in the uterus.

§ Skin, 0.4 per cent (total weight of skin was estimated as 14 per cent of body weight); bone, 2.8 per cent (analysis was made on an alkaline digest of cleanly dissected femur, and total weight of bone was estimated as 13 per cent of body weight); pancreas, 0.7 per cent.

¶ Skin, 0.7 per cent; bone, 5.6 per cent; pancreas, 0.7 per cent.

sis included organs of the body cavity, the entire gastrointestinal tract, and samples of muscle. In some cases samples of skin and bone were also taken. Their content of organic iodine was determined by the chloric acid method, and the corresponding content of the radiopaque was calculated. The results are given in Table II.

The data indicate that the cat excretes about 45 per cent of a 0.5 gm./kg. dose of sodium diatrizoate in one hour, 80 per cent in 3 hours, and 92 per cent in 5 hours. This is a slightly faster excretion rate than observed in the dog, in spite of the lower dose level. Comparisons among diatrizoate and the other urographic agents were made only at the 3-hour interval. They show that cats excrete diatrizoate more rapidly than acetrizoate or iodopyracet, but no more rapidly than iodomethamate.

The studies of the localization of diatrizoate, at the early intervals after injection (30 and 60 minutes), show that the largest amounts are found in muscle and plasma, with smaller but significant amounts in liver, kidneys, and contents of the gastrointestinal tract. The pattern of the tissue distribution is such as to suggest that the compound is contained mostly in the extracellular fluid. With the passage of time, the radiopaque is rather rapidly removed and transported to the kidneys for excretion; no special predilection for any organ or tissue is evident. Among the four contrast agents studied, there is no noteworthy difference in tissue distribution, except for the fact that the acetrizoate and iodopyracet which have not been excreted within 3 hours are found mostly in the muscle.*

* The cat evidently does not excrete through the bile nearly as much as the 20 per cent of acetrizoate which Porporis *et al.*[3] estimate for the dog. Since the amount of diatrizoate found in the

With all agents and at all times the plasma concentration exceeds considerably that in the red cells.

D. *Mechanism of Excretion of Diatrizoate.* The recent study of Porporis and co-workers[8] on the mechanism of excretion of acetrizoate suggested that comparable data on the excretion of diatrizoate would be of interest. These workers have shown that the presence of acetrizoate in the plasma causes a decrease in the renal clearance of p-aminohippuric acid, roughly proportional to the amount of the contrast medium injected, and a smaller but definite decrease in the clearance of inulin. Furthermore, they found that the clearances of acetrizoate and inulin are similar at plasma concentrations (of the former) comparable to those which would result from the dosages of this urographic agent which are used clinically. They concluded, therefore, that acetrizoate is excreted chiefly by a process of glomerular filtration.

Procedures. Three healthy adult male dogs weighing 7–10 kg. were used as subjects for the renal clearance studies. Their phenolsulfonphthalein (PSP) excretion was first established as at least 65 per cent in 90 minutes† (see Table IV). The clearance studies were carried out almost exactly as described by Porporis *et al.*[8]; each dog eventually received 6 injections of contrast agent, first receiving a dose of 0.5 gm./kg. of sodium diatrizoate, followed by doses of 2.5, 5, and 2.5 gm./kg. of the same agent. Finally, they received two doses of 2.5 gm./kg. of sodium acetrizoate.‡ The second 2.5 gm./kg. dose of each agent was used to study its effect on simultaneous PSP excretion rate, while the other doses were given to study the effects on renal clearances of p-aminohippuric acid (PAHA) and of inulin. In all of the experiments, except those involving PSP excretion, the clearances of inulin and PAHA were determined just before and after the injection of the urographic agents, according to the schedule and procedures of Porporis *et al.*[8] Clearances of the urographic agent were determined for the post-injection period (that is, during the period 10–50 minutes after completing the radiopaque injection). In most cases determinations of the clearances of PAHA and inulin were repeated by the same procedures, 24 hours after the injections of the contrast media.

Urine collections were made, both pre- and post-injection, for 3 periods of 13 ± 0.3 minutes each. (The bladder was washed out with 20 ml. of water at the end of each period.) Blood samples were taken at the beginning (and end) of each urine collection period, and the plasma was analyzed for inulin, for PAHA, and for the urographic agent (where indicated). The plasma levels so determined were plotted against time, and the amount estimated as being in the plasma 5 minutes after the beginning of each urine collection period was used to calculate the clearance for that period.

Inulin was determined in plasma and urine by the method of Ranney and McCune;[9] protein-free filtrates were prepared as described by Czok, Kreienberg and Mertz,[1] and PAHA was determined in plasma and urine by the method of Czok and co-workers. The radiopaques were determined in plasma and urine by the chloric acid method of Zak and Boyle.[15] The results of the experiments are presented in Table III.

Comment. As regards toxic manifestations, it may be stated that injection of as much as 5 gm./kg. of sodium diatrizoate was well tolerated by all of the animals. The same dose level of sodium acetrizoate had killed 2 of 3 animals in the experiments of Porporis *et al.*,[8] and one of our dogs (19103) encountered some difficulty with the 2.5 gm./kg. dose of sodium acetrizoate, as was indicated by marked dyspnea. As regards clearances of PAHA, it is evident that none of the three dose levels of

gastrointestinal tract of the cat is definitely less at 5 hours than it is at 1 or 3 hours, some reabsorption must occur. The total amount of diatrizoate finally excreted in the feces by the cat probably does not exceed 4 per cent of the dose.

† In our experience, more than 30 per cent PSP excreted in one hour, and at least 60 per cent in 2 hours, is reasonably satisfactory for the dog.

‡ There was an interval of one week between experiments in each dog. Each animal, therefore, received all of its injections in 6 weeks of elapsed time.

Table III

EFFECT OF THE INTRAVENOUS INJECTION OF SODIUM DIATRIZOATE AND OF SODIUM ACETRIZOATE ON THE RENAL CLEARANCES OF P-AMINOHIPPURIC ACID AND OF INULIN IN DOGS

Dog No.	Compound Injected	Dose, gm./kg.	Pre-injection Clearances ml./min.* PAHA**	Pre-injection Clearances ml./min.* Inulin**	Post-injection Clearances ml./min.* PAHA	Post-injection Clearances ml./min.* Inulin	Post-injection Clearances ml./min.* Urographic Agent	Per Cent Change in Clearances, Pre-injection vs. Post-injection PAHA	Per Cent Change in Clearances, Pre-injection vs. Post-injection Inulin	24 Hr. Post-injection Clearances, ml./min.* PAHA	24 Hr. Post-injection Clearances, ml./min.* Inulin	Urographic Agent in Plasma during Clearance, mg. per cent Mean‡	Urographic Agent in Plasma during Clearance, mg. per cent Range	Excretion Rate of Urographic Agent, mean‖ Mg./Min.	Excretion Rate of Urographic Agent, mean‖ Mg./Min. Sq. m.
19099	Sodium diatrizoate	0.5†	112 ± 10	25 ± 1	91 ± 9	23 ± 2	24 ± 1	−19	−8	—	—	90	45–162	41	106
19103	Sodium diatrizoate	0.5	116 ± 2	24 ± 2	115 ± 9	25 ± 1	28 ± 2	−1	+4	—	—	134	84–207	37	73
19113	Sodium diatrizoate	0.5	94 ± 4	35 ± 4	92 ± 2	32 ± 1	30 ± 1	−2	−8	99 ± 8	36 ± 2	106	64–172	33	76
Mean ± s.e.§			107 ± 7	28 ± 3	99 ± 8	27 ± 3	27 ± 2	−7 ± 4	−4 ± 4	—	—	110 ± 13	—	37 ± 2	85 ± 11
19099	Sodium diatrizoate	2.5†	145 ± 48	35 ± 13	161 ± 19	33 ± 2	34 ± 2	+11	−6	176 ± 51	37 ± 9	458	270–732	161	418
19103	Sodium diatrizoate	2.5	97 ± 20	25 ± 5	94 ± 3	22 ± 1	20 ± 0	−3	−12	80 ± 11	22 ± 2	692	475–974	140	280
19113	Sodium diatrizoate	2.5	109 ± 16	39 ± 12	93 ± 0	30 ± 2	29 ± 1	−15	−23	100 ± 5	43 ± 5	577	365–859	169	390
Mean ± s.e.§			117 ± 15	33 ± 4	116 ± 23	28 ± 3	28 ± 4	−2 ± 8	−14 ± 5	119 ± 29	34 ± 6	575 ± 66	—	157 ± 9	363 ± 42
19099	Sodium diatrizoate	5.0†	113 ± 26	29 ± 8	106 ± 4	27 ± 2	29 ± 1	−6	−7	159 ± 31	38 ± 3	828	550–1221	251	650
19103	Sodium diatrizoate	5.0	118 ± 8	30 ± 4	75 ± 5	22 ± 1	21 ± 1	−36	−27	85 ± 20	25 ± 4	1211	876–1624	255	510
19113	Sodium diatrizoate	5.0	90 ± 19	32 ± 5	83 ± 3	29 ± 1	32 ± 1	−8	−9	85 ± 3	32 ± 2	895	578–1298	290	670
Mean ± s.e.§			107 ± 9	30 ± 1	88 ± 9	27 ± 3	27 ± 4	−17 ± 9	−14 ± 6	110 ± 25	32 ± 4	978 ± 118	—	265 ± 12	610 ± 50
19099	Sodium acetrizoate	2.5¶	172 ± 14	40 ± 1	46 ± 7	32 ± 2	28 ± 1	−73	−20	140 ± 18	41 ± 2	440	274–695	122	316
10103	Sodium acetrizoate	2.5	88 ± 5	24 ± 1	16 ± 2	10 ± 1	11 ± 1	−81	−58	78 ± 6	19 ± 1	828	661–1100	96	192
19113	Sodium acetrizoate	2.5	87 ± 8	32 ± 0	35 ± 2	26 ± 1	25 ± 1	−60	−19	71 ± 9	29 ± 1	495	363–612	124	286
Mean ± s.e.§			116 ± 28	32 ± 5	32 ± 8	23 ± 7	21 ± 5	−71 ± 6	−32 ± 13	96 ± 22	30 ± 6	588 ± 122	—	114 ± 9	264 ± 37

* Mean of 3 observations ± s.e. The urine collection periods were 13 ± 0.3 min.

† There was an interval of one week between sodium diatrizoate injections in each dog.

‡ Mean of 4 values. The first sample was taken ten minutes after the injection of the urographic agent, and the others at 13 minute intervals thereafter.

§ Standard errors of the means.

¶ The injections of sodium acetrizoate were made one week after the 2.5 gm./kg. dose of sodium diatrizoate, and two weeks after the 5 gm./kg. dose, except in the case of dog no. 19113. In this case the acetrizoate followed by one week a second 5 gm./kg. dose of diatrizoate.

‖ For the period 10–50 minutes after injection of the urographic agent.

** The mean pre-injection clearance of PAHA for the three dogs, as ml./min./sq. m., was 260 ± 45; the corresponding value for inulin was 72 ± 10. Mean filtration fraction = 0.277. Body area calculated as:

$$\frac{11.2 \times (\text{gm. body weight})^{2/3}}{10{,}000}.$$

sodium diatrizoate, except possibly the highest, produced a statistically significant decrease. Generally speaking, the variability of response of the animal from one experiment to another, or even from one urine collection period to another, was greater than the difference between the mean pre-injection and post-injection clearances for that animal. The single exception to this generalization was dog 19103, on the 5 gm./kg. dose. In the over-all picture, the post-injection decrease in PAHA clearances (for all dogs and doses) was no greater than the concomitant (per cent) decrease in inulin clearances. In interpreting the data in the table, it should be pointed out that although no great significance can be attached to the standard error of only three observations, these figures have been included because they make clear in a very concise way the variability of the individual values which compose the mean, and permit judgment as to whether the pre-injection and post-injection values overlap one another, or are quite different.

Clearances of diatrizoate, as expected from the work of Porporis *et al.*[8] were practically identical with those of inulin. The logical interpretation of these data, along with those on PAHA clearances, would be that diatrizoate is excreted by a process of glomerular filtration, that it does decrease slightly (by competition) the excretion rate of substances which are eliminated by this process, but that it does not interfere significantly with tubular transport and secretion.

Our partial repetition of the work of the Porporis group on acetrizoate essentially confirms their findings. A 2.5 gm./kg. dose of this agent, in our hands, decreases the post-injection clearances of PAHA by an average of 71 per cent, as compared to a mean decrease of 67 per cent observed by Porporis *et al.*[8] There can be, therefore, no doubt that there is a significant difference between the effects of the two agents in the dog. While acetrizoate had an unexpectedly adverse effect on inulin clearances in our hands (a mean decrease of 35 per cent, as compared to about 15 per cent observed by Porporis *et al.*,[8] on the same dose), some allowance must be made for the fact that our animals had already received amounts of diatrizoate totaling over 40 times the single clinical dose (200 mg./kg.), and, furthermore, that most of this mean decrease was contributed by one animal. It was this same animal (19103) which demonstrated the greatest difficulty in tolerating the injection of acetrizoate, and also the one in which the renal clearances were most adversely affected by the 5 gm./kg. dose of diatrizoate. A 35 per cent decrease in the clearance of inulin following a 2.5 gm./kg. dose of sodium acetrizoate, therefore, is not necessarily typical for the dog.

Another difference between the two agents apparent from the last column of the table is that, at comparable dose levels, the excretion rate of acetrizoate is about 72 per cent of that of diatrizoate.* This difference correlates well with the comparative excretion rates of the two agents in cats, as reported in Table II, and with the difference in their rates of excretion by dogs as set forth in Section A of this paper.

Table IV presents data on PSP excretion obtained at various times during the experiments. Row A of the table shows that the PSP excretion was normal prior to any of the medications.† After having received three separate diatrizoate medications (row B), two dogs excreted about 10 per cent less PSP in 2 hours, but the third showed no change. Subsequently, one of the former (dog no. 19113) showed at least a partial recovery, and its excretion rate (row D) would be considered normal. The primary purpose of making these determinations, however, was to ascertain whether diatrizoate and acetrizoate affect simultaneous PSP excretion in dogs, and in the same manner as in man (*i.e.*, a reduction to 5–15

* Harrow[2] has pointed out still another difference; *i.e.*, that diatrizoate causes the excretion of an alkaline urine, while acetrizoate decreases urinary pH. He suggests that the former may be a carbonic anhydrase inhibitor.

† In our experience, more than 30 per cent PSP excreted in one hour, and at least 60 per cent in 2 hours, is reasonably satisfactory for the dog.

TABLE IV

EFFECT OF THE INTRAVENOUS INJECTION OF SODIUM DIATRIZOATE AND SODIUM ACETRIZOATE ON THE PHENOLSULFONPHTHALEIN (PSP) EXCRETION OF DOGS
AMOUNT EXCRETED, AS PER CENT OF DOSE*

Test	Dog No. and time intervals in minutes											
	19099				19103				19113			
	0–30	30–60	60–120	2-hr. Total	0–30	30–60	60–120	2-hr. Total	0–30	30–60	60–120	2-hr. Total
A. Prior to any medications	27	34	17	78	29	26	17	72	25	29	11‡	65‡
B. After completion of three sodium diatrizoate medications (0.5, 2.5, and 5 gm./kg.)†	34	28	14	76	18	22	20	60	37 10	2 16	17 27	56 53
C. During excretion of the fourth diatrizoate medication (2.5 gm./kg.)	14	26	31	71	16	20	24	60	17	20	24	61§
D. After four diatrizoate medications and one acetrizoate medication†	31	32	14	77	11	24	29	64	12	23	29	64
E. During excretion of the second acetrizoate medication (2.5 gm./kg.)	4	11	21	36	2	7	19	28	—	—	—	—

* One ml. (6 mg.) given intramuscularly.
† At least 24 hours after the last of these.
‡ In this case the collection was concluded at 90 minutes. Estimated total for 120 minutes, 70 per cent.
§ This animal had received an additional 5 gm./kg. of sodium diatrizoate and one 2.5 gm./kg. sodium acetrizoate medication before this test was run. Its excretion of PSP after these 5 medications is given under D. This was, therefore, its sixth medication.

per cent of the dye excreted, as compared to a normal excretion of 60–75 per cent, in 45–60 minutes, has been reported[2]). As may be seen from row C of the table, no comparable decrease occurs in the dog during the excretion of a 2.5 gm./kg. dose of diatrizoate. Acetrizoate at the same dose level, however, causes a decrease in the 2-hour PSP excretion to somewhat less than half its normal value (row E). This difference in action could have been anticipated from the clearance data in Table III, and is in accord with the concept that the dog excretes PAHA and PSP by similar mechanisms at low plasma concentrations of the latter.

SUMMARY

The urinary excretion of sodium diatrizoate has been studied in cats and dogs, and its tissue distribution in comparison to other commonly used urographic contrast agents has been studied in the former species. Of a 1 gm./kg. dose of sodium diatrizoate, two-thirds is excreted by dogs in 2 hours, and 88 per cent in 6 hours; in the cat 80 per cent of a 0.5 gm./kg. dose is excreted in 3 hours, and 90 per cent in 5 hours. The latter figures compare with 60–65 per cent of acetrizoate and of iodopyracet, and about 80 per cent of iodomethamate excreted by the cat, in 3 hours. The tissue distribution of all of these agents in the cat is such as to suggest that they are contained mostly in the extracellular fluid, and have no special predilection for any tissue or organ.

The administration of as much as 5 gm./kg. of sodium diatrizoate to dogs reduces only slightly (about 10 per cent) the renal clearances of PAHA and of inulin. However, the injection of 2.5 gm./kg. of sodium acetrizoate decreases markedly (about 70 per cent) the renal clearance of PAHA, and the inulin clearance is also reduced, although to a lesser extent. This indicates that there is a fundamental difference in the manner in which the two contrast agents are excreted by the dog. It would appear that both radiopaques are excreted by a process of glomerular filtration, but that diatrizoate does not enter

the tubules to a sufficient extent to affect the tubular transport and secretion of PAHA. Further evidence of a fundamental difference in the mechanism of excretion is to be found in the fact that the injection of sodium diatrizoate does not significantly delay the simultaneous excretion of PSP by the dog, while sodium acetrizoate decreases the first-hour PSP excretion of this species very markedly.

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SIMPLE SENSITOMETRIC CONTROL OF DEVELOPER ACTIVITY

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THE production of consistently optimum quality roentgenograms is obligatory if roentgenologic techniques are to attain their greatest clinical value. This is possible only with adequate control and maintenance of the many factors which affect quality.[7,8] Contrast is a primary factor in interpretability of the roentgenogram. The process of development is of fundamental importance in determining the shape and gradient of the density curve and is thus of major importance in rendering contrast.[5] Particularly when exposures are phototimed and films are processed automatically, it is necessary to control the strength and quality of the developing solution in order to obtain optimum film-exposure-development combinations. One of the authors (R.L.N.) some years ago developed such a method.[4] It has been used for five years at The University of Chicago and has proved both practicable and simple.

Several methods of darkroom control have been previously reported.[1,2,3,9] Those utilizing roentgenographic apparatus have the admitted inherent difficulty of calibrating from one test film to the next due to the lack of constancy of output from time to time. Chemical methods seem attractive but test only the oxidation-reduction potential of the developer. The chemical fog level, influence of physical as well as chemical development, and the complicated interaction of other salts in the developer cannot be determined by simple chemical methods so far proposed. Adequate film-exposure-development control can be obtained best by sensitometric methods and by plotting of the characteristic curve of the film-developer combination in use. Under laboratory conditions the sensitometry of film and developing agent can be separated and studied independently; such techniques are too complicated and are essentially unnecessary for practical sensitometry in clinical application.

The method of testing darkroom function, which will be detailed here, utilizes a series of exposures on standard roentgenographic film processed through the solutions to be tested. The resulting densities are determined by means of a densitometer and recorded in graph form for convenience of inspection and permanent record. The apparatus required consists of a standard light source (*i.e.*, a constant intensity light), a neutral density step wedge and a densitometer.

THE STANDARD LIGHT SOURCE

Visible light was chosen as the means for producing the test film exposure because of simplified and easily controllable operation and the economy of building a standard light source. Since the roentgenographic effect is generally from the visible light produced in intensifying screens, the relationships of reciprocity law failure are maintained by such a system, as opposed to the situation that holds if the test strips are produced by roentgen rays without the use of screens. The light is built much like a contact printer, using an 8 by 10 inch contact printing frame (Fig. 1).

The light source used is a 12-volt automobile headlight. This light was chosen because of the relatively great filament to glass distance. This construction detail reduces possible variation in light intensity by minimizing filament emission deposit on the glass envelope of the light. The light is operated by a constant voltage transformer

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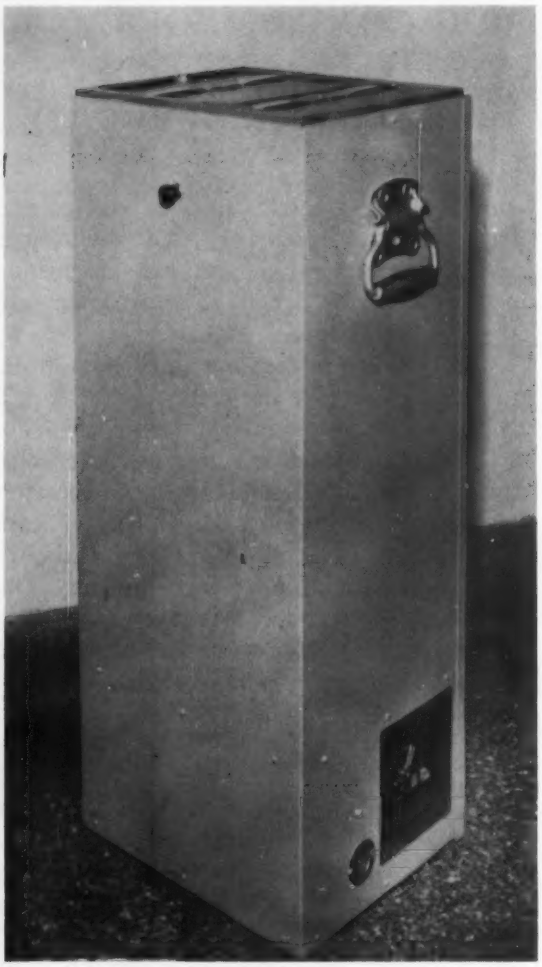

Fig. 1

(Sola-Type 30881). The 6-volt output of the transformer is connected in series through both filaments of this light. Thus, each filament burns at one-fourth the normal voltage, further reducing filament deterioration and emission deposit. The transformer is connected through a Cramer timer switch to allow reproducible exposures of up to 15 seconds with adequate accuracy. A relatively long exposure is chosen to minimize variation. The light is housed in a dust-tight box which rigidly fixes the position of transformer, light, diffusing plates, neutral density step wedge and printing frame. Figure 2 gives details of construction of the standard light source and the simple circuit diagram. Black felt is used between the edges of the diffusing plate and the box to produce light-tight and relatively dust-tight joints. The inside of the box is painted with optical black to eliminate changes due to deterioration of reflecting surfaces. The cost of parts (Table 1) is at the present time less than $75.00.

The standard light source detailed represents a modified intensity-scale sensitometer. The exposure time selected, while long enough to minimize variation, is not completely dissociated from that used in practice. The intensity is modulated by an accurate step tablet or optical wedge, thus producing sensitometric data of practical significance.

THE NEUTRAL DENSITY STEP WEDGE

The purpose of the neutral density step wedge is to facilitate production of several different exposures on the test film, utilizing only one exposure from the standard light source. The wedge is made by suitable exposure and development of standard roentgenographic film. The successive degrees of density of this film are chosen so that the proportion of light transmitted by the several steps decreases in approximately linear steps of a logarithmic scale. An opaque section achieved by means of a strip of aluminum foil allows examination of the developed base density of the final test strip.

The neutral density wedge can be prepared using the standard light source plus an accurate external timer inserted in the circuit at point x (Fig. 2). We have used the hand timer from our portable roentgen-ray generator for this purpose. The several steps of preparing this final wedge should be completed in one session; otherwise, minor changes in developer strength will cause annoying variations. A number of fresh 8 by 10 films of the same manufacturer's lot plus a fresh supply of solutions should be sequestered for this purpose. At this point the exposure increments of the routine film strip must be decided upon and the corresponding density of the several steps of the neutral wedge calculated. We elected to use a seven step wedge and show the calculations in Table II. Next, a series of test exposures are made with the

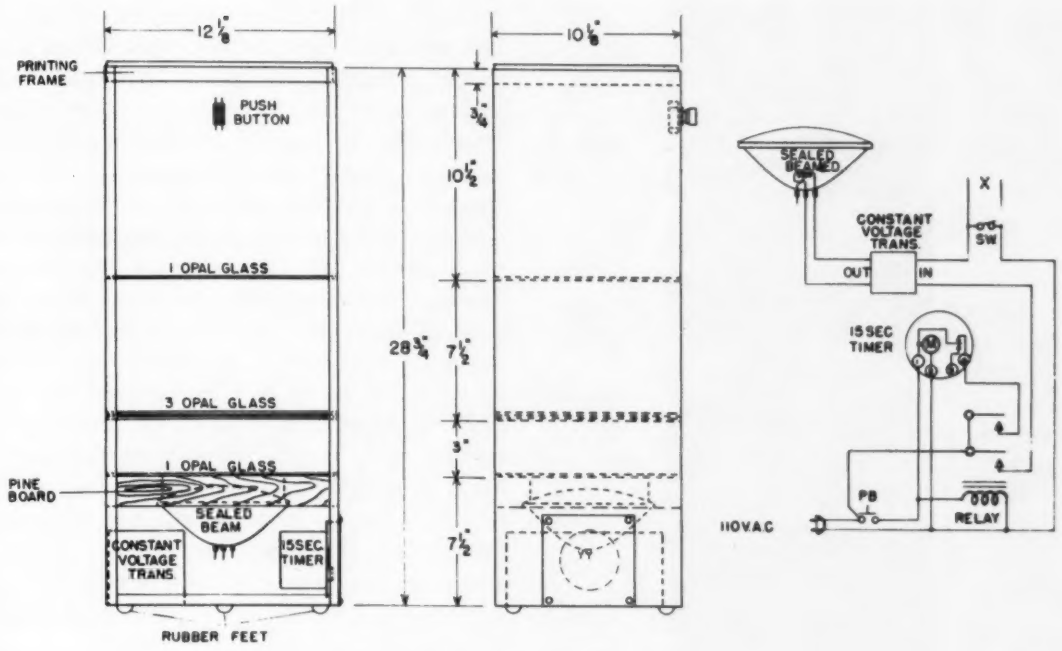

Fig. 2

Table I

1	6-volt voltage stabilizing step-down transformer, Sola-Type 30881
1	12-volt sealed beam automobile headlamp
1	15-second Cramer timer WD 189 Type-TD1, 110 volt, 60 cycle, SPDT
1	DP relay
1	momentary push button—normally open, Arrow H & H 3392
8	feet Tyrex cord
1	male plug
5	10″×12⅛″ pieces opal glass
1	48″×30″ sheet steel, 18 gauge
1	34″×30″ sheet steel, 20 gauge

standard light, using exposures of increasing length. Successive strips of film may be blacked out by using aluminum foil. From these random exposures a preliminary D vs. log E graph is prepared. The exposures required to produce the desired densities of the step wedge may be read from this graph. The neutral density wedge may now be prepared. Several attempts may be required before a wedge of the desired accuracy can be obtained. Minor variations of wedge density (and, therefore, of the exposure produced in each routine film strip)

Table II

STEPS OF NEUTRAL DENSITY WEDGE

Exposure increments transmitted to routine film strip	0	3	6	12	25	50	100
Transmission of density wedge to achieve "A"—(maximum transmission 0.71 assumes base density of film used to make wedge = 0.15)	0	.02	.04	.08	.18	.35	.71
D (or $\frac{\text{Log I}}{\text{transmission}}$) required to produce these exposure increments	∞	1.67	1.41	1.07	0.75	0.45	0.15

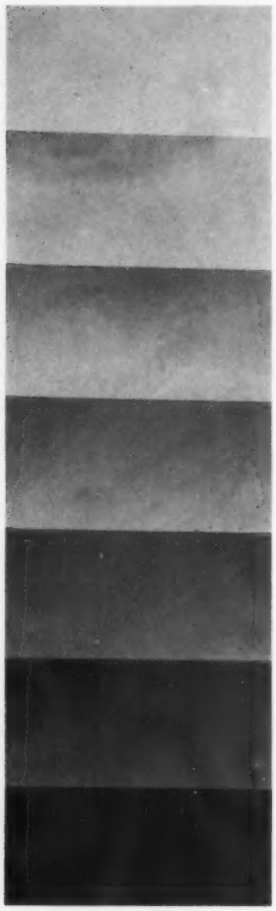

Fig. 3

can be corrected in the preparation of the graph form used to record the result of the routine test.

THE DENSITOMETER

The densitometer presently used is an Ansco-Macbeth photoelectric densitometer. Previous measurements were made using the Eastman Color Densitometer Model 1, a less expensive instrument. Use of the photoelectric densitometer removes all subjectivity from the process of density interpretation and somewhat speeds the process of reading the film strips but is by no means necessary in order to produce the desired degree of accuracy.

THE ROUTINE FILM STRIP

The film used for routine daily or weekly test of the developer is made by exposing a piece of standard roentgenographic film in the standard light source with the neutral density wedge interposed between light and test film. The test film must be in contact with the neutral density wedge. The exposure for the test strip is arbitrarily chosen to produce a density between 2.0 and 2.5 in the most heavily exposed section of the strip. Once this exposure has been selected, the Cramer timer is set to this time and all successive exposures of test strips are made in the same manner.

An 8 by 10 inch film exposed for test may be cut in inch-wide strips. For routine testing, two weeks' supply of test strips may be prepared at one time without detectable variation of result due to latent image fading. A number of films from a single manufacturer's lot should be set aside for use as test strips. When changing to another lot, strips from each lot should be developed at the same time to detect minor film variations which might otherwise be attributed to variations of the developer.

After a test strip has been processed in the same manner as clinical films (Fig. 3), the successive steps are read with the densitometer. The result of each test is then plotted on a graph of D vs. log E. For convenience, this graph paper may be mimeographed showing only the exposure steps

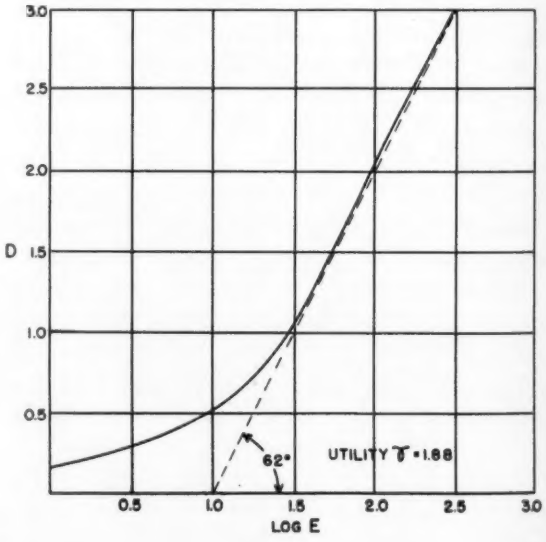

Fig. 4

produced by the wedge (Fig. 4). The desired result may be included as a dotted line on the mimeographed blank, thus facilitating quick comparison of the periodic test with the desired developer function. The desired curve should not be derived by test in new developer; a slight decrease of contrast occurs after development of the first few films and must be counted as normal.

The tangent of the angle formed by the intersection of the extrapolated straight line portion of the characteristic curve and the log E axis is numerically equal to gamma, which is sometimes referred to as the development factor,[6] and indicates the ability of the film-solution combination to produce contrast.

INTERPRETATION OF RESULTS

The resulting plot of D vs. log E will display variation of darkroom processing functions before it becomes of clinical significance. Elevation of the foot of the curve indicates an increase in background or chemical fog. Ordinarily the foot of this curve lies at about 0.15. When it is elevated to 0.25, the fogging becomes clinically appreciable. At the present time the only solution to this difficulty seems to be discarding the solution and resuming operation with fresh developer. Investigations are being conducted with certain chemical anti-foggants in order to determine if their use will result in prolonging the life of developer under these conditions. When the straight line portion of the curve shifts to left, the activity of the developer is too great. Correction can be accomplished by decrease in the rate of replenishment. Conversely, a shift to right implies need to increase replenishment rate.

Determination of absolute gamma requires primary standards and precise control of numerous technical factors. The term "utility gamma" is proposed to designate a value more simply determined but adequate for clinical radiology.[4]

Increase of utility gamma (the curve is steeper) implies increase of contrast. Correction can be accomplished by addition of a small amount of bromide.

SUMMARY

The problem and benefits of control of darkroom function have been discussed. A sensitometric method for developer control is outlined and detailed specifications for the construction of the necessary apparatus and its use are given. The method is not expensive and its routine use is simple.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY, RADIUM THERAPY AND NUCLEAR MEDICINE

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Fifty-eighth Annual Meeting: Shoreham Hotel, Washington, D. C., October 1–4, 1957.

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Representative on the Board of Chancellors of the American College of Radiology: Charles L. Martin, Dallas, Texas.

Fortieth Annual Meeting: Hollywood, Fla. Date and hotel to be announced.

EDITORIAL

FIFTY-EIGHTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

THE Fifty-eighth Annual Meeting of the American Roentgen Ray Society will be held at the Shoreham Hotel, Washington, D. C., Tuesday, Wednesday, Thursday and Friday, October 1–4, 1957. The Nation's Capital is an ideal place for a meeting of our Society because it is a beautiful and fascinating city and the Shoreham Hotel is noted for gracious hospitality. Twice before, in 1951 and 1954, we have met in Washington. Each time, the meetings have been unusually well attended and most pleasant in every way. No small measure of their success has been due to the friendly reception given us by the Washington radiologists and the efficient work of their Committee on Local Arrangements. This year, the Chairman is Dr. Edgar M. McPeak and the Ladies Committee is under the able direction of Mrs. Edgar M. McPeak.

The management of the Shoreham Hotel has just completed its building program during which the entrance foyer and the registration section were enlarged and modernized. An attractive cocktail lounge is now just off the lobby and there are several additional larger rooms for the Instructional Courses. These improvements will no doubt add to the enjoyment of the meeting.

All members and guests are urged to make their reservations immediately in order that they may have the accommodations they desire. Very shortly, the Shoreham Hotel will mail the members of the Society a colored pamphlet describing their facilities.

The Commercial Exhibits will again be housed in the West Lobby Foyer and in the Main Ballroom, which, as you will recall, are connected by the unique "Bird-Cage Walk." Dr. James C. Cook, Manager of the Annual Meeting, has obtained an unusually large number of exhibits and practically every bit of available space has already been taken. All equipment and accessory manufacturers will be represented as will the prominent publishers and pharmaceutical companies. Their new developments and intriguing wares will tempt you to spend many hours looking them over. "Cliff" Sherratt has arranged for the Commercial Exhibits to be open from 8:30 A.M. to 5:00 P.M.

Dr. John F. Holt, Chairman of the Scientific Exhibits Committee, has gathered together a fascinating group of exhibits. These will be in the commodious and air conditioned West Ballroom and adjacent Foyer which makes it possible to have a large number of exhibitors. From the high quality of exhibits already offered, there is little doubt but what the secret Committee on Awards will find adequate reasons for giving out the Gold, Silver and Bronze Medals, as well as many Certificates of Merit and Honorable Mention.

The Scientific Exhibits will be open from 8:30 A.M. until 8:00 P.M. each day. By keeping the exhibits open for two hours in the evening, everyone will be permitted ample time to study them.

We all know that the Meeting of the American Roentgen Ray Society really opens with the Annual Golf Tournament for all members and guests. This will be held on Monday, September 30, 1957. Dr. Raph M. Caulk, the Chairman of the Local Golf Committee, has obtained permission from the Board of Governors of the Manor Country Club for us to be his guests. Those who have played the course in 1954 will re-

call its rolling hills, intriguing greens and tree-lined fairways. The clubhouse facilities are most attractive and we are assured of a delicious dinner and lunch. This is always a rousing good party and everyone is urged to attend the lucheon and dinner, whether he plays golf or prefers to relax on the porch. At the conclusion of the dinner, the Willis F. Manges Trophy for the Eighteen Hole Medal Handicap and the Exhibitors Trophy for the Eighteen Hole Gross Score with other prizes will be awarded the "noble" and "lucky" golfers. After this, Arthur Fuchs and his Eastman colleagues will show the colored movies of last year's tournament held at the beautiful but devastatingly trapped Wilshire Country Club at Los Angeles. Transportation will be provided to and from the Manor Country Club.

Registration begins at 2:00 P.M. on Sunday, September 29 and thereafter will be continued each day from 8:00 A.M. to 5:00 P.M. The registration desk will be in the foyer leading to the Commercial Exhibits.

The Scientific Sessions will be held in the Terrace Banquet Room Tuesday through Friday, beginning at 8:30 A.M. and ending at 12:30 P.M. The meeting will be called to order on Tuesday morning, October 1, by the President, Dr. W. Edward Chamberlain, after which Dr. Edward B. D. Neuhauser, Chairman of the Executive Council, will assist Dr. Chamberlain in the installation of the President-Elect, Wendell G. Scott.

The Preliminary Program is published elsewhere in this issue of the JOURNAL. The Program Committee began working last fall to assemble and select the papers and symposia. The Scientific Session starts Tuesday morning with a very important symposium on *Today's Problems in Radiation Hazards and What Is Being Done about Them.* It will be followed by three papers on *New Clinical Procedures for Minimizing Radiation Dose.* The problems of radiation exposure and protection are probably the most urgent facing radiology today. The morning session will be topped off by Dr. David W. Smithers, Professor of Radiotherapy in the University of London and Director of the Radiotherapy Department at the Royal Marsden Hospital and Institute of Cancer Research, the Royal Cancer Hospital, who will speak on *Long Survival in Advanced Carcinoma of the Breast.* Dr. Smithers will be a guest of the Society and will also give Instructional Courses on *Hodgkin's Disease* and on *Carcinoma of the Esophagus.*

On Tuesday evening at 8 o'clock is the highlight of the meeting, The Caldwell Lecture, which this year will be given by Dr. Eugene P. Pendergrass, Professor of Radiology at the University of Pennsylvania School of Medicine, Philadelphia. Dr. Warren W. Furey will make the introduction.

On Wednesday, the Scientific Session will be concerned largely with problems related to the management of patients with advanced cancer and papers dealing with the newer concepts of tissue radiation responses, chemotherapy, and the application of hormones. Another group of papers will concern examinations of the gastrointestinal tract. Dr. Leo. G. Rigler has arranged a symposium on *Exotic Diseases of the Lungs* which should prove most interesting. The morning session will end with a paper on *Lung Changes in Acquired Heart Disease* by Dr. Peter J. Kerley, Physician-in-Charge, X-ray Department, Westminster Hospital, London, England. Dr. Kerley just completed three years as President of The Faculty of Radiologists and is Co-Editor with Shanks and Twining of the well known textbook, "Recent Advances in Radiology." We are indeed fortunate that Dr. Kerley will be in this country and can participate in our meeting. He has also agreed to give an Instructional Course on the *Diagnosis of Cardiac Disorders.*

The Past Presidents' Luncheon is to be held in the South Room from 12:30 to 2:00 P.M. on Wednesday.

On Thursday morning, the first half of the Scientific Session will be taken up with papers on arteriography, angiocardiog-

raphy, splenoportography and the discussion of *Selection of Cases for Intracardiac Surgery* by Dr. John W. Kirklin, who has accepted our invitation to discuss this subject. These papers will be followed by a symposium on *Benign Bone Lesions in Childhood* arranged by Dr. Edward B. D. Neuhauser. The session will be concluded with a paper by Dr. Marshall Brucer, Medical Director of the Oak Ridge Institute of Nuclear Studies, who has been invited to present *Developments of Brachytherapy Devices*. Thursday evening at 7:30 P.M. is the Annual Banquet in the Terrace Banquet Room. It is preceded by a cocktail party from 6:30 to 7:30 in the lower lobby and, if weather permits, on the terrace by the fountain. Dr. McPeak and his Committee have arranged a program of delightful entertainment which will be followed by dancing. Since there will be no "speeches," everything is set for a gala evening.

On Friday morning, the Scientific Session will begin with a group of papers on radiation therapy followed by a group on gastrointestinal disorders. The session will be concluded by Dr. Fred C. D. Collier, Associate Pathologist, Hospital of the University of Pennsylvania, and co-workers, who will discuss *The Prognostic Impact of Vascular Invasion in Lung Cancer*.

The business meetings of the Society will be held at 4:30 P.M. in the Terrace Room on Tuesday and Thursday afternoons.

Dr. Harold O. Peterson, Director of the Instructional Courses, has been very busy completing arrangements for over 55 different courses, which will provide an unusually varied group from which to choose. The members of the Faculty have been selected with the thought of offering the latest developments and ideas in the diagnostic and therapeutic fields. The Instructional Courses will be held each afternoon, Tuesday through Friday, from 3:00 to 4:30 P.M. As in the past, the members and guests will be required to fill out application blanks for the Instructional Courses they desire to attend and will receive their tickets in advance of the meeting. The details of the Instructional Courses will be published in the August issue of the JOURNAL.

The Washington meetings have always been popular with the ladies and this year, Mrs. Edgar M. McPeak and her Committee have arranged for a theater party for Monday evening, September 30, 1957, for the ladies and for any members or guests who wish to join them. This will provide an evening of pleasure for those who do not attend the Golf Tournament and Dinner. Transportation will be provided to and from the theater. On Tuesday afternoon, there will be a Fashion Show and Tea at the Cuban Embassy from 3:00 to 5:00 P.M. The Embassy is a beautiful building and the occasion should provide a delightful afternoon. Again, the transportation will be furnished. On Wednesday, there is a sight seeing tour to Annapolis, Maryland, with luncheon served at Carvel Hall. Thursday is a free day which the ladies can devote to shopping. On Friday is the tour to Mount Vernon with a luncheon in historic Alexandria, Virginia. Arrangements have also been made for ladies to play golf at any of the local golf courses. Incidentally, the husbands can go along if they desire.

This year's Washington Meeting of the American Roentgen Ray Society promises again to be an excellent one in most pleasant surroundings which have been previously visited and thoroughly enjoyed by most of us.

A cordial invitation is extended not only to the Members of the Society but to all radiologists, their wives and guests to attend this Annual Meeting.

WENDELL G. SCOTT, M.D.
President-Elect

100 North Euclid
St. Louis, Missouri

SOCIETY PROCEEDINGS AND NEWS ITEMS

MEETINGS OF RADIOLOGICAL SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Shoreham Hotel, Washington, D. C., Oct. 1–4, 1957.

American Radium Society
Secretary, Dr. Theodore R. Miller, New York, N. Y. Annual meeting: To be announced.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y. Annual meeting: To be announced.

American College of Radiology
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6, Illinois. Annual meeting: To be announced.

Section on Radiology, American Medical Association
Secretary, Dr. T. Leucutia, Harper Hospital, Detroit 1, Mich. Annual meeting, June 23–27, 1958, San Francisco, Calif.

Eighth International Congress of Radiology
Secretary General, Dr. José Noriega, Calle del Oro 15, Mexico 7, D. F.

Alabama Radiological Society
Secretary, Dr. J. A. Meadows, Jr., Medical Arts Bldg., Birmingham 5, Ala. Meets time and place Alabama State Medical Association.

American Nuclear Society
Dr. L. D. P. King, Los Alamos Scientific Laboratory, Post Office Box 1663, Los Alamos, N. M.

Arizona Radiological Society
Secretary, Dr. R. Lee Foster, 1313 N. Second St., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

Arkansas Radiological Society
Dr. E. A. Mendelsohn, Holt-Krock Clinic, Fort Smith, Ark. Meets every three months and also at time and place of State Medical Association.

Association of University Radiologists
Secretary, Dr. David M. Gould, University of Arkansas Medical Center, Little Rock, Ark.

Atlanta Radiological Society
Secretary, Dr. Charles M. Silverstein, 3254 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

Blockly Radiological Society
Secretary, Dr. Samuel Finkelman.

Brooklyn Radiological Society
Secretary, Dr. Harold N. Schwinger, 62 8th Ave., Brooklyn, N. Y. Meets first Thursday of each month October through May.

Buffalo Radiological Society
Secretary, Dr. Charles Bernstein, 685 Delaware Ave., Buffalo, N. Y. Meets second Monday evening each month, October to May inclusive.

Central New York Roentgen Ray Society
Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse, N. Y. Meets January, May, November.

Central Ohio Radiological Society
Secretary, Dr. Arthur R. Cohen, 41 S. Grant Ave., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, November, January, March and May at Fort Hayes Hotel, Columbus, Ohio.

Central Society of Nuclear Medicine
Secretary, Dr. Robert S. Landauer, Radiation Center Building, 1903 West Harrison St., Chicago 12, Ill.

Chicago Roentgen Society
Secretary, Dr. Arthur S. J. Petersen, 11406 Parnell Ave., Chicago 28, Ill. Meets second Thursday of each month, October to April inclusive at the Sheraton Hotel.

Cleveland Radiological Society
Secretary, Dr. A. S. Tucker, 2065 Adelbert Rd., Cleveland 6, Ohio. Meetings at 7:00 P.M. on fourth Monday of each month from October to April at Tudor Arms Hotel.

Colorado Radiological Society
Secretary, Dr. Lorenz R. Wurtzebach, 601 Nineteenth Ave., Denver, Colo. Meets third Friday of each month at Denver Athletic Club.

Connecticut Valley Radiologic Society
Secretary, Dr. T. J. Crowe, 53 Center St., Northampton, Mass. Meets second Friday October and April.

Dallas-Fort Worth Radiological Club
Secretary, Dr. A. H. Keene, 3707 Gaston Ave., Dallas, Texas. Meets monthly, third Monday, at Greater Fort Worth International Airport at 6:30 P.M.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. Joseph O. Reed, Jr., Harper Hospital, Detroit, Mich. Meets monthly first Thursday, Oct. through May, at David Whitney House, 4421 Woodward Ave., at 6:30 P.M.

East Bay Roentgen Society
Secretary, Dr. Dan Tucker, 434 30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

Florida Radiological Society
Secretary, Dr. C. Robert DeArmas 135 Broadway, Daytona Beach, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

Georgia Radiological Society
Secretary, Dr. B. H. Malone, 1406 Reynolds St., Brunswick, Ga.

Greater Miami Radiological Society
Secretary, Dr. George P. Daurelle, Jackson Memorial Hospital, Miami, Fla. Meets monthly third Wednesday at 8 P.M. at Mercy Hospital, Miami, Fla.

Greater St. Louis Radiological Society
Secretary, Dr. Thomas F. Maher, 1015 Missouri Theater Bldg., St. Louis, Mo.

Houston Radiological Society
Secretary, Dr. John M. Phillips, 1203 Ross Sterling Ave., Houston 25, Texas. Meets fourth Monday each month, Meeting Room, Doctors' Club of Houston.

Idaho State Radiological Society
Secretary, Dr. Alfred M. Stone, St. Lukes Hospital, Boise, Idaho. Meets annually at same time as Idaho State Medical Association.

Illinois Radiological Society
Secretary, Dr. Stephen L. Casper, 1101 Maine St., Quincy, Ill. Meets three times a year.

Indiana Roentgen Society
Secretary, Dr. C. A. Stayton, 313 Hume-Mansur Bldg., Indianapolis 4. Meets first Sunday in May and during fall meeting of Indiana State Medical Association.

Iowa Radiological Society
Secretary, Dr. James T. McMillan, 1104 Bankers Trust Bldg., Des Moines, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. The scientific section is held in the autumn.

* Secretaries of societies are requested to send timely information promptly to the Editor.

Kansas Radiological Society
Secretary, Dr. James R. Stark, 3244 E. Douglas, Wichita, Kansas. Meets in spring with State Medical Society, and in winter on call.

Kentucky Radiological Society
Secretary, Dr. Robert H. Akers, 1405 West Broadway, Louisville 3, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Kings County Radiological Society
Secretary, Dr. Ernest I. Melton, 2187 Ocean Ave., Brooklyn 19, N.Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

Los Angeles Radiological Society
Secretary, Dr. Lewis J. Peha, 405 North Bedford Drive, Beverly Hills, Calif. Meets second Wednesday each month at Los Angeles County Medical Association Building, Los Angeles.

Maine Radiological Society
Secretary, Dr. Irving L. Selvago, Jr., Maine Medical Center, 22 Arsenal St., Portland, Maine. Meets in June, September, December and March.

Maryland Radiological Society
Secretary, Dr. Nathan B. Hyman, 1805 Eutaw Place, Baltimore, Md.

Memphis Roentgen Society
Secretary, Dr. James L. Booth, 899 Madison Ave., Memphis 4, Tenn. Meets first Monday of each month at John Gaston Hospital.

Miami Valley Radiological Society
Secretary, Dr. H. D. Robertson, Miami Valley Hospital, Dayton 9, Ohio. Meets second Friday of fall and winter months.

Mid-Hudson Radiological Society
Secretary, Dr. J. W. Walton, Horton Memorial Hospital, Middletown, N. Y. Meets 8:30 P.M., fourth Tuesday each month, September to May.

Milwaukee Roentgen Ray Society
Secretary, Dr. R. W. Bryne, 3321 N. Maryland Ave., Milwaukee 1, Wis. Meets monthly on fourth Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. O. J. Baggenstoss, 1953 Medical Arts Bldg., Minneapolis, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Mississippi Radiological Society
Secretary, Dr. Robert P. Henderson, 316 Medical Arts Bldg., Jackson, Miss. Meets third Thursday of each month at Hotel Edwards, Jackson, at 6:00 P.M.

Montana Radiological Society
Secretary, Dr. John Stewart, 1105 Frederick Lane, Billings, Montana. Meets at least once a year.

Nassau Radiological Society
Secretary, Dr. Jerome Zwanger, 126 Hicksville Rd., Massapequa, L. I., N. Y. Meets second Tuesday of the month in February, April, June, October and December.

Nebraska Radiological Society
Secretary, Dr. J. F. Kelly, Jr., 816 Medical Arts Bldg., Omaha, Neb. Meets third Wednesday of each month at 6 P.M. in Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. Raymond A. Dillon, 24 Wedgemere Ave., Winchester, Mass. Meets third Friday of each month, October through May, at Hotel Commander, Cambridge, Mass.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. Harold G. Jacobson, 210th St. and Bainbridge Ave., New York 67, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. William H. Sprunt, North Carolina Memorial Hospital, Chapel Hill, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. Marianne Wallis, St. Joseph's Hospital, Minot, N. D. Meetings by announcement.

North Florida Radiological Society
Secretary, Dr. Marvin Harlan Johnston, Five Points Medical Center, Jacksonville, Fla. Meets quarterly in March, June, September and December.

Northeastern New York Radiological Society
Secretary, Dr. Irving Van Woert, Jr., Albany Hospital, Albany, N. Y. Meets in Albany area on second Wednesdays of October, November, March and April.

Northern California Radiological Society
Secretary, Dr. H. B. Stewart, 2920 Capital Ave., Sacramento, Calif. Meets at dinner last Monday of each month, September to June.

Ohio State Radiological Society
Secretary, Dr. John R. Hannan, 10515 Carnegie Ave., Cleveland 6, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. Sol Wilner, St. John's Hospital, Tulsa, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. N. L. Bline, 210 Jackson Tower, Portland 5, Ore. Meets monthly from October to June on the second Wednesday of each month at 8:00 P.M. at the University Club.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. J. R. Raines, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. Walter P. Bitner, 234 State Street, Harrisburg, Pa.

Philadelphia Roentgen Ray Society
Secretary, Dr. Roderick L. Tondreau, 3400 Spruce St., Philadelphia, Pa. Meets first Thursday of each month, at 5 P.M., from October to May in Thompson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary, Dr. N. B. Tannehill, 601 Jenkins Bldg., Pittsburgh 22, Pa. Meets second Wednesday of month, October through June at Hotel Roosevelt.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Paul W. Roman, 1810 Eutaw Place, Baltimore 17, Md. Meets third Tuesday each month, September to May, inclusive.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of Greater Cincinnati
Secretary, Dr. Morris M. Garrett, 630 Scott St., Covington, Ky. Meets monthly from September to May on first Monday of each month at 7:30 P.M. at the Cincinnati General Hospital.

Radiological Society of Hawaii
Secretary, Dr. Richard D. Moore, St. Francis Hospital, Honolulu 17, T. H. Meets third Monday evening of each month at designated hospitals.

Radiological Society of Greater Kansas City
Secretary, Dr. E. H. Stratemeier, Jr., 1010 Rialto Building, Kansas City 6, Mo. Meets last Friday of each month.

Radiological Society of Kansas City
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

Radiological Society of Louisiana
Secretary, Dr. W. S. Neal, 602 Pere Marquette Bldg., New Orleans, La. Meets annually during Louisiana State Medical Society Meeting.

Radiological Society of New Jersey
Secretary, Dr. G. G. Green, 601 Grand Ave., Asbury Park, N. J. Meets at Atlantic City at time of State Medical Society and in November in Newark, N. J.

Radiological Society of Southern California
Secretary, Dr. Robert B. Engle, 2632 E. Washington St., Pasadena, Calif.

Richmond County Radiological Society
Secretary Dr. W. F. Hamilton, Jr., University Hospital, Augusta, Ga. Meets first Thursday of each month at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. John W. Colgan, 277 Alexander St., Rochester 18, N. Y. Meets at 8:15 P.M. on the last Monday of each month, September through May, at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. John H. Freed, 4200 East Ninth St., Denver 20, Colo. Annual midsummer meeting: Shirley-Savoy Hotel, Denver, Colo., Aug. 15–17, 1957.

St. Louis Society of Radiologists
Secretary, Dr. Edwin C. Ernst, Jr., 3720 Washington Ave., St. Louis 8, Mo. Meets fourth Wednesday each month, except June, July, Aug. and Sept.

San Antonio-Military Radiological Society
Secretary, Dr. Hugo F. Elmendorf, Jr., 730 Medical Arts Bldg., San Antonio 5, Texas. Meets Brooke Army Medical Center Officers Mess second Wednesday of each month.

San Diego Radiological Society
Secretary, Dr. J. C. Asher, 2001 Fourth Ave., San Diego 1, Calif. Meets first Wednesday of each month at the University Club.

San Francisco Radiological Society
Secretary, Dr. Irma Smith, 450 Sutter St., San Francisco 18, Calif. Meets quarterly at Grison's Steak House.

Section on Radiology, California Medical Association
Secretary, Dr. A. R. Wilson, 540 North Central Ave., Glendale 3, Calif.

Section on Radiology, Connecticut State Medical Society
Secretary, Dr. J. Burbank, Meriden Hospital, Meriden, Conn. Meetings are held bi-monthly.

Section on Radiology, Medical Society of the District of Columbia
Secretary, Dr. Melvin O. Goodman, 1930 K St., N.W., Washington 6, D. C. Meets Medical Society Library, third Wednesday of January, March, May and October at 8:00 P.M.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. George E. Irwin, Jr., 703 N. East St., Bloomington, Ill.

Shreveport Radiological Club
Secretary, W. R. Harwell, 608 Travis St., Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M. September to May inclusive.

Society of Nuclear Medicine
Secretary, Dr. Robert G. Moffat, B. C. Cancer Institute, 2656 Heather Street, Vancouver 9, Canada. Annual meeting to be announced.

South Bay Radiological Society
Secretary, Dr. Howard L. Jones, Palo Alto Hospital, Palo Alto, Calif. Meets second Wednesday of each month.

South Carolina Radiological Society
Secretary, Dr. S. W. Lippincott, 103 Rutledge Ave., Charleston, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Southern Radiological Conference
Secretary, Dr. Marshall Eskridge, Mobile Infirmary, Mobile, Ala.

Southwestern Radiological Society
Secretary, Dr. Gordon Black, Suite 2-A, El Paso Medical Center, 1501 Arizona, El Paso, Texas. Meets second Tuesday of each month.

Tennessee Radiological Society
Secretary, Dr. G. K. Henshall, 311 Medical Arts Bldg., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. J. E. Miller, Baylor Hospital, Dallas, Texas.

Tri-State Radiological Society
Secretary, Dr. Robert E. Beck, 600 Mary St., Evansville, Ind. Meets last Wednesday of Oct., Jan., March and May, 8:00 P.M. at Elks' Club in Evansville.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7:00 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May, Service Memorial Institute.

Upper Peninsula Radiological Society
Secretary, Dr. A. Gonty, Menominee, Mich. Meets quarterly.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets fourth Wednesday in January, March, May, September and November at Holy Cross Hospital.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. Eva L. Gilbertson, 1317 Marion St., Seattle 4, Wash. Meets fourth Monday of each month from September through May at 610 Pine St., Seattle.

West Virginia Radiological Society
Secretary, Dr. W. Paul Elkin, 515 Medical Arts Bldg., Charleston, W. Va. Meets concurrently with annual meeting of West Virginia State Medical Society; other meetings arranged by program committee.

Westchester Radiological Society
Secretary, Dr. M. G. Priestman, New Rochelle Hospital, New Rochelle, N. Y. Meets on third Tuesday of January and October and on two other dates.

Wisconsin Radiological Society
Secretary, Dr. Farrell F. Golden, 5221 Tonyawatha Trail, Madison, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. John H. Heald, 450 Sutter St., San Francisco 8, Calif. Meets monthly, third Thursday at 7:30 P.M., Children's Hospital, September through June.

Cuba, Mexico, Puerto Rico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Costarricense de Radiologia
Secretary, Dr. James Fernández Carballo, Apartado VIII, San Jose, Costa Rica.

Sociedad Mexicana de Radiología, A. C.
Calle del Oro No. 15, Mexico 7, D. F.
Secretary General, Dr. Guillermo Santín. Meets first Monday of each month.

Asociación Puertorriqueña de Radiología
Secretary, Dr. R. B. Diaz Bonnet, Suite 504, Professional Bldg., Santurce, Puerto Rico.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86, Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

Association of Radiologists of the Province of Quebec
Secretary, Dr. Isadore Sedlezky, 3755 Cote St. Catherine Rd., Montreal, Que. Meets four times a year.

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1

Faculty of Radiologists
Honorary Secretary, Dr. R. A. Kemp Harper, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Secretary, Dr. Isadore Sedlezky, 3755 Cote St. Catherine

Rd., Montreal, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electro-Radiologie Médicales
General Secretary, Dr. Ls Ivan Vallée, 1058 rue St-Denis, Montreal 18, Canada. Meets third Saturday each month.

College of Radiologists (Australia and New Zealand)
Honorary Secretary, Dr. Alan R. Colwell, c/o British Medical Agency, 135 Macquarie St., Sydney, N.S.W.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mosca, Avda. Gral. Paz 151 Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia, Junta Central, Buenos Aires
Secretary, Dr. Oscar F. Noguera, Santa Fe 1171, Buenos Aires. Meetings are held monthly.

Sociedad Argentina de Radiologia, Filial del Litoral, Sede, Rosario
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 19 ha 663 Italia St., Rosario, Santa Fe.

Sociedad Argentina de Radiologia, Filial del Sur, Sede, La Plata
President, Prof. Dr. Jose P. Uslenghi, La Plata. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Centro Sede, Córdoba
President, Prof. Dr. David L. Caro, Corro 86, Córdoba. Meets monthly.

Sociedad Argentina de Radiologia, Filial del Norte, Sede, Tucuman
President, Dr. Julio Mendez Valladares, Rivadavia 358, Tucuman. Meets monthly.

Sociedad Argentina de Radiologia, Filial de Cuyo Sede, Mendoza
President, Dr. J. A. Orfila, Hospital Central, Mendoza. Meets monthly.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem. de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9:00 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Chilena de Radiologia
Secretary, Dr. Armando Doberti, Merced 565, Santiago, Chile. Meets fourth Friday of each month.

Sociedad Colombiana de Radiologia
Secretary, Dr. Luis E. Lozano B., Carrera 12 No. 20–69, 6° piso, Bogotá, Colombia. Meets last Thursday of each month.

Sociedad Ecuatoriana de Radiologia y Fisioterapia
Secretary, Dr. Enrique Ortega Guzmán, Casilla 4719, Guayaquil, Ecuador.

Sociedad Peruana de Radiologia
Secretary, Dr. Luis Pinillos G. Apartado 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta 218, Lima.

Sociedad de Radiologia del Atlantico
Secretary, Dr. Raul Fernandez, Calle 40 #41-110, Baranquilla, Colombia. Society meets monthly at the Instituto de Radiologia.

Sociedad de Radiología, Cancerología y Física Médica del Uruguay
Secretary General, Dr. Roberto François, Av. Agraciada 1464, Piso 13, Montevideo, Uruguay.

Sociedade de Radiologia de Pernambuco
Secretary, Dr. Manoel Medeiros, Instituto de Radiologia da Faculdade de Medicina da Universidade do Recife, Caixa Postal 505, Pernambuco, Brazil.

Sociedad Venezolana de Radiología
Secretary, Dr. Otto Paz, Centro Médico, Caracas, Venezuela. Meets monthly third Friday at Colegio Médico del Distrito Federal, Caracas.

Continental Europe

Austrian Roentgen Society
President, Dr. Konrad Weiss, Mariannengasse 10, Vienna 9, Austria. Meets second Tuesday of each month in Allegemeine Poliklinik.

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 256 Chaussée de Wavre, Heverlee-lez-Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Société Française d'Electro-Radiologie Médicale, and its branches: Société du Sud-Ouest, de Littoral Méditerranéen, de Centre et du Lyonnais, de l'Ouest, de l'Est, et d'Alger et d'Afrique du Nord
Secretary-General, Dr. A. Dariaux, 9 bis, Boulevard Rochechouart, Paris IX^e^, France.

Ceskoslovensk společnost pro rëntgenologii a Radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Deutsche Röntgen-Gesellschaft
Secretary, Dr. med. Peter Kröker, Evangelisches Krankenhaus, Huyssens Stiftung, (22a) Essen.

Societa Italiana de Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano, Torino, Italy. Meets biannually.

Nederlandse Vereniging voor Electrologie en Roentgenologie
Secretary, Dr. B. J. Rethmeier, Bornsestraat 378, Almelo, Netherlands.

Polish Society of Radiology
Secretary, Dr. Juljusz Borejko, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10:30, X-Ray Dept. Akademia Gdansk.

Wroclaw Section, Polish Society of Radiology
Secretary, Dr. R. Marciniak, Akad. Medyczna Wroclaw, 68 Curie-Sklodowska St., Wroclaw, Poland. Meets first Sunday of each month, X-Ray Department, Akademia Medyczna Wroclaw.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S.I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Española de Radiologia y Electrologia
Secretary, Dr. D. Aureo Gutierrez Churruca, Esparteros, No. 9, Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société-Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

India

Indian Radiological Association
Secretary, Dr. R. F. Sethna, Navsari Building, Hornby Road, Bombay 1, India.

The list of Meetings of Radiological Societies is published in every other issue of the Journal.

PRELIMINARY PROGRAM

FIFTY-EIGHTH ANNUAL MEETING OF THE AMERICAN ROENTGEN RAY SOCIETY

The Fifty-eighth Annual Meeting of the American Roentgen Ray Society will be held at the Shoreham Hotel, Washington, D. C., October 1–4, 1957.

The Executive Council will meet on Sunday, September 29.

The Annual Golf Tournament for the Willis F. Manges Trophy for the Eighteen Hole Medal Handicap and the Exhibitors' Trophy for the Eighteen Hole Gross Score will be held at the Manor Country Club, and the Annual Golf Dinner will be held at the same place after the tournament.

Dr. Eugene P. Pendergrass will give the Caldwell Lecture on Tuesday evening, October 1. The Annual Banquet will be held on Thursday evening, October 3, in the Terrace Banquet Room.

The Instruction Courses will be held each afternoon, Tuesday through Friday, from 3:00 to 4:30 P.M. The detailed plan of the Instruction Courses will be published in the August issue of the JOURNAL.

The Scientific Program, which has been arranged by President-Elect Wendell G. Scott and his Program Committee, is as follows:

Tuesday, October 1, 1957
Terrace Banquet Room

8:30 A.M. Call to order, Fifty-eighth Annual Meeting, W. Edward Chamberlain, M.D., President.

Installation of President-Elect, Wendell G. Scott, M.D., St. Louis, Mo., by W. Edward Chamberlain, M.D., President, Philadelphia, Pa., and Edward B. D. Neuhauser, M.D., Chairman of the Executive Council, Boston, Mass.

9:00 A.M.

Presiding: Wendell G. Scott, M.D.
St. Louis, Mo.

Symposium: Today's Problems in Radiation Hazards and What is Being Done about Them. Edith H. Quimby, Sc.D., Chairman, New York, N. Y.

Paper No.

1. Introduction and Statement of Problem. Edith H. Quimby, Sc.D., New York, N. Y.
2. Factors Influencing Maximum Permissible Limits of Exposure. Gioacchino Failla, Sc.D., New York, N. Y.
3. The Genetic Hazards of Atomic Radiations. Bentley Glass, Ph.D. (by invitation), Washington, D. C.
4. Radiation Dosage in Routine Diagnostic Procedures. John S. Laughlin, Ph.D. (by invitation), New York, N. Y.
5. Minimizing Radiation Exposure in Diagnostic Examinations. Lauriston S. Taylor, Ph.D., Washington, D. C.
6. Past and Present Radiation Exposure to Radiologists from the Point of View of Life Expectancy. Carl B. Braestrup, B.S., P.E. (by invitation), New York, N. Y.
7. Common Sense in Radiation Protection Applied to Clinical Procedures—Past and Present Developments. Robert S. Stone, M.D., San Francisco, Calif.
8. Summarization. Richard H. Chamberlain, M.D., Philadelphia, Pa.
   New Clinical Procedures for Minimizing Radiation Dose.
9. Clinical Applications of Potassium Iodide Intensifying Screens in Contrast Media Roentgenography. Michel Ter-Pogossian, Ph.D. (by invitation), and Torgny Greitz, M.D. (by invitation), St. Louis, Mo.
10. A Solid State Amplifying Fluoroscope Screen. Benjamin Kazan, B.S., M.A. (by invitation), Princeton, N. J.
11. New Clinical Procedures for Minimizing Radiation Dosage. Russell H. Morgan, M.D., Baltimore, Md.
12. Long Survival in Advanced Carcinoma of the Breast. David W. Smithers, M.D., F.R.C.P., F.F.R. (by invitation), London, England.

Tuesday Evening, October 1, 1957

Eight O'Clock

The Caldwell Lecture

"Atmospheric Pollutants and the Radiologist"

by

Eugene P. Pendergrass, M.D.
Professor of Radiology
University of Pennsylvania
School of Medicine
Philadelphia, Pa.

Introduction—
Warren W. Furey, M.D.
Clinical Professor of Roentgenology
Loyola University School of Medicine
Chicago, Ill.

Presentation of the Caldwell Medal to Dr. Pendergrass by President Scott

Wednesday, October 2, 1957

8:30 A.M.

Presiding: Vincent W. Archer, M.D.
Charlottesville, Va.

13. Newer Concepts of Tissue-Radiation Response. Henry S. Kaplan, M.D. (by invitation), San Francisco, Calif.
14. Clinical Cancer Chemotherapy. Alfred Gellhorn, M.D. (by invitation), New York, N. Y.
15. Clinical Applications of Hormones in the Management of Advanced Cancer. Byrl J. Kennedy, M.D. (by invitation), Minneapolis, Minn.

Discussion of papers 13, 14, and 15 by L. Henry Garland, M.D., San Francisco, Calif.

16. Roentgen Diagnosis of Benign Gastric Ulcer. Harold O. Peterson, M.D., and Frank C. Giddings, M.D. (by invitation), St. Paul, Minn.
17. Face-On Gravity Demonstration of Gastric Ulcer in a Dependent Position. Richard Schatzki, M.D., and John E. Gary, M.D., Brookline, Mass.
18. Diagnosis of Tumors of the Pancreas with the Aid of Retroperitoneal Pneumonography and Splenoportography. Robert D. Moseley, Jr., M.D. (by invitation), Chicago, Ill.

Discussion of papers 16, 17, and 18 by C. Allen Good, M.D., Rochester, Minn.

Symposium: Exotic Diseases of the Lungs.
Leo G. Rigler, M.D., Chairman,
Minneapolis, Minn.

19. Introduction. Leo G. Rigler, M.D., Minneapolis, Minn.
20. Less Familiar Roentgen Manifestations of Fungus Disease, Sarcoid, and Other Granulomas of the Lung. Benjamin Felson, M.D. (by invitation), Cincinnati, Ohio.
21. Pulmonary Manifestations in Collagen Diseases. Charles M. Nice, Jr., M.D., A. N. K. Menon, M.B., B.S., D.M.R., D.M.R.D. (by invitation), and Leo G. Rigler, M.D., Minneapolis, Minn.
22. Some Unusual Manifestations of Staphylococcal Pneumonia in Infancy. Gunter Schultze, M.D. (by invitation), Baltimore, Md.
23. Lung Changes in Acquired Heart Disease. Peter J. Kerley, M.D., F.R.C.P., F.F.R. (by invitation), London, England.

Thursday, October 3, 1957

8:30 A.M.

Presiding: Philip J. Hodes, M.D.
Philadelphia, Pa.

24. Arteriography in Neoplasms of the Extremities. Alexander R. Margulis, M.D. (by invitation), and Thomas O. Murphy, M.D. (by invitation), Minneapolis, Minn.
25. Roentgen Evaluation of Pulmonary Hypertension in Routine Chest Roentgenograms. Eugene F. Van Epps, M.D., Iowa City, Iowa.
26. The Reaction of the Heart to Catheterization and to Angiocardiography. Bernard J. O'Loughlin, M.D., Los Angeles, Calif.
27. Congenital Heart Disease: Selection of Cases for Intracardiac Surgery. John W. Kirklin, M.D. (by invitation), Rochester, Minn.
28. Splenoportography, Assets and Liabilities. Melvin M. Figley, M.D. (by invitation), Ann Arbor, Mich.
29. Paravertebral and Azygos Venous Systems, and Variations of Systemic Venous Return in Man. Herbert L. Abrams, M.D. (by invitation), San Francisco, Calif.

Symposium: Benign Bone Lesions in Childhood.
Edward B. D. Neuhauser, M.D.,
Chairman, Boston, Mass.

30. Introduction. Edward B. D. Neuhauser, M.D., Boston, Mass.
31. Pelvic Stigmas in the Mongoloid Infant. John Caffey, A.B., M.D., and Steven Ross, M.D. (by invitation), New York, N. Y.
32. New Radiologic Aspects of Metabolic Bone Disease. John F. Holt, M.D., Ann Arbor, Mich.
33. Juvenile Unicameral Bone Cysts. Gwilym S. Lodwick, M.D., Columbia, Mo.

Discussion opened by Arthur E. Childe, M.D., Winnipeg, Canada.

34. The Development of Brachytherapy Devices. Marshall Brucer, M.D. (by invitation), Oak Ridge, Tenn.

Friday, October 4, 1957

8:30 A.M.

Presiding: Harry M. Weber, M.D.
Rochester, Minn.

35. Radiation Therapy in Solitary Benign Cystic Bone Tumors of Children. James C. Cook, M.D., Kenneth L. Krabbenhoft, M.D. (by invitation), and Robert A. Songe, M.D. (by invitation), Detroit, Mich.
36. The Uses and Limitations of Cobalt 60 Hectocurie Teletherapy. Norman Simon, M.D., and Sidney M. Silverstone, M.D., New York, N. Y.
37. The Effect of Anemia on the Radiocurability of Carcinoma of the Cervix. Manuel Garcia, M.D. (by invitation), and George Hoeffler, M.D. (by invitation), New Orleans, La.
38. Carcinoma of the Palatine Tonsil. Paul W. Scanlon, M.D. (by invitation), Rochester, Minn.

Discussion of papers 35, 36, 37, and 38 by Traian Leucutia, M.D., Detroit, Mich.

39. The Effects of Irradiation on Pulmonary Function. William T. Moss, M.D. (by invitation), and S. K. Sweany, M.D. (by invitation), Chicago, Ill.
40. The Roentgen Findings in Lymphosarcoma of the Small Intestine. Richard H. Marshak, M.D., Bernard S. Wolf, M.D., and Joan Eliasoph, M.D. (by invitation), New York, N. Y.
41. Demonstration of Fistulous Tracts Secondary to Abscess Formation in Diverticulitis with Intestinal Communication. Charles E. Bickham, Jr., M.D. (by invitation), Washington, D. C.
42. Diaphragmatic Hernia in Infancy. Joseph O. Reed, Jr., M.D. (by invitation), and Ernst F. Lang, M.D., Detroit, Mich.
43. Ultra-Short (Millisecond) Timing and a Rapid Film Changer in Roentgen Diagnostic Procedures, Including Angio-Cardiography: Evaluation of Dynapulse and Impulse Timing. Barton R. Young, M.D., Robert B. Funch, M.D. (by invitation), and Jay W. MacMoran, M.D. (by invitation), Philadelphia, Pa.
44. The Prognostic Impact of Vascular Invasion in Lung Cancer. Fred C. D. Collier, M.D. (by invitation), Robert H. Kyle, M.D. (by invitation), H. T. Enterline, M.D. (by invitation), Theodore Tristan, M.D. (by invitation), and Roy Greening, M.D. (by invitation), Philadelphia, Pa.

RADIATION PROTECTION GROUP APPOINTS NEW EXECUTIVE COMMITTEE

The National Committee on Radiation Protection and Measurements (NCRP) has announced a change in the membership of its executive committee. Sponsored by the National Bureau of Standards, the NCRP is an advisory group of experts in various phases of the radiation field, and is made up of representatives from the following organizations: American College of Radiology, American Dental Association, American Industrial Hygiene Association, American Medical Association, American Radium Society, American Roentgen Ray Society, International Association of Government Labor Officials, National Bureau of Standards, National Electrical Manufacturers Association, Radiological Society of North America, U. S. Air Force, U. S. Army, U. S. Atomic Energy Commission, U. S. Navy and U. S. Public Health Service. The recommendations of the Committee are published by the U. S. Government Printing Office in the NBS Handbook series.

The members of the new executive committee and their institutional affiliations are as follows: L. S. Taylor, Chairman, Atomic and Radiation Physics Division, National Bureau of Standards; E. C. Barnes, Industrial Hygiene Department, Westinghouse Electric Corporation; C. B. Braestrup, Physics Laboratory, Francis Delafield Hospital (City of New York Department of Hospitals); C. L. Dunham, Division of Biology and Medicine, U. S. Atomic Energy Commission; J. Bentley Glass, Department of Biology, Johns Hopkins University; H. M. Parker, Hanford Laboratories, General Electric Company; Clinton Powell, Division of Special Health Services, U. S. Public Health Service; Robert S. Stone, Medical Center, University of California; Shields Warren, Cancer Research Institute, New England Deaconess Hospital.

AEBERSOLD BECOMES ASSISTANT DIRECTOR OF AEC DIVISION OF CIVILIAN APPLICATION

Dr. Paul C. Aebersold, who has been Director of the Atomic Energy Commission's Isotopes Extension at Oak Ridge, Tennessee, has been transferred to the Commission's Washington headquarters as Assistant Director for Isotopes and Radiation, Division of Civilian Application.

The Isotopes Extension was made part of the Division of Civilian Application in January, 1956, when administrative responsibility for the isotopes distribution program was transferred to the Division from the Commission's Oak Ridge Operations office.

Since 1946, Dr. Aebersold has directed the distribution program under which radioisotopes, as peaceful byproducts of atomic energy, have been introduced into several thousand institutions, universities, hospitals and industrial firms in the United States and abroad. Earlier Dr. Aebersold had been associated with various war-time atomic energy projects in Berkeley, Calif., Oak Ridge, Tenn., and Los Alamos, New Mexico.

THE AMERICAN BOARD OF RADIOLOGY

The Spring 1958, Meeting of the American Board of Radiology will be held at the Palmer House, Chicago, Illinois, May 19–23, inclusive. The deadline for filing applications for this examination is January 1, 1958. Correspondence is to be directed to The American Board of Radiology, Kahler Hotel Building, Rochester, Minnesota.

REPORT OF THE INTERNATIONAL COMMISSION ON RADIOLOGICAL UNITS AND MEASUREMENTS

The 1956 recommendations of the International Commission on Radiological Units and Measurements (ICRU) have been published as National Bureau of Standards Handbook 62. This report covers the recommendations of the ICRU as agreed upon at its meetings in Geneva in April, 1956, and replaces its earlier report issued in 1953. The new report includes an extensive amount of basic information and data necessary to make radiation dose measurements in energy units (rads), and to convert data expressed in roentgens to the equivalent in energy units.

Copies of this publication may be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C., at a cost of 40 cents each. It is anticipated that translations of the report will be made into other languages.

X-RAY STUDIES OF PHOTOGRAPHIC FILM

National Bureau of Standards
U. S. Department of Commerce
Washington 25, D. C.

Experiments recently performed by the National Bureau of Standards provide data on the photographic response of commercial X-ray films at unusually high rates of exposure.[1] The work was supported by the U. S. Atomic Energy Commission and

[1] For further technical details, see *The reciprocity law for X-rays, Part I: Validity for high-intensity exposures in the negative region; Part II: Failure in the reversal region*, by M. Ehrlich and W. L. McLaughlin, *J. Opt. Soc. Am.*, 46, 797, and 801 (Oct. 1956).

the U. S. Army Signal Corps, and the experiments were conducted by Margarete Ehrlich and W. L. McLaughlin of the Bureau's radiation physics laboratory.

Previous studies had used exposure rates up to about 60 roentgens per second (r/sec.) and a ratio of lowest to highest exposure rates of 1 to 10,000. The exposure rates used in the Bureau's experiments extended to about 1,100 r/sec., with a ratio of lowest to highest rates of 1 to 30,000. The results confirm the validity of the reciprocity law for exposures on the ascending branches of the characteristic curves of two widely used commercial X-ray films, over the exposure-rate range covered in the experiment. The results also establish the failure of the reciprocity law in the reversal region of the characteristic curve of one of the two film types over the same exposure rate range.

Plans for further work are under consideration by the Bureau.

INTER-AMERICAN COLLEGE OF RADIOLOGY

The Sixth Inter-American Congress of Radiology will take place in Lima, Peru, November 2 to 8 of 1958. Dr. Jorge de la Flor, Hospital Arzobispo Loayzo, Lima, Peru is the Secretary for North America. Anyone desiring further information, application blanks, etc. may write to Dr. de la Flor.

RAYMOND C. BEELER LECTURESHIP

The recently established Raymond C. Beeler Lectureship in Radiology was inaugurated at the Indiana University School of Medicine in February, 1957 when the initial lectures were presented by Dr. George D. Davis. Dr. Davis, a 1938 graduate, is now a member of the radiology staff at the Mayo Clinics. In presenting the "Beeler Lectures" before audiences of radiologists from Indiana and nearby states, Dr. Davis discussed *Problems in Roentgen Diagnosis of Peptic Ulcer* during the afternoon, and *Roentgenologic Aspects of Painful Hips in Adults* at a dinner-meeting.

The lectureship honors Dr. Raymond C. Beeler, professor of radiology and member of the faculty since 1919. He relinquished the Chairmanship of the department several months ago after a quarter of a century of devoted service to the department in the School of Medicine from which he received his M.D. degree in 1912. Dr. Beeler is a past President of the American Roentgen Ray Society and has received many professional recognitions during his career.

When he joined the staff in 1919, the "department" occupied space next to the boiler room in the Long Hospital. A nearby closet served as a darkroom and space under the hospital porch was used for film storage. The equipment included a gas-type X-ray tube suspended on a wooden arm which could be placed in vertical or horizontal positions with the patient lying on a couch.

Today the department averages more than 100 diagnostic and therapeutic procedures daily. Modern equipment, ranging from a million-volt therapy unit to a new device for making X-ray movies of the heart and other body organs, is now em ployed.

BOOK REVIEWS

Books sent for review are acknowledged under: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interest of our readers as space permits.

THE XIV JAPAN MEDICAL CONGRESS. APRIL 1–5, 1955. KYOTO. Part I and Part II. Edited by The Bureau of Archives, The XIV Japan Medical Congress at the Faculty of Medicine, Kyoto University. Paper. Price, $6.00. Pp. 733, with numerous illustrations. The Bureau of Archives, The XIV Japan Medical Congress, Department of Pathology, Faculty of Medicine, Kyoto University, Yoshida, Sakyo-ku, Kyoto, Japan, 1956.

In April, 1955, the Fourteenth Japan Medical Congress was held at Kyoto University. Attended by representatives of 44 sectional societies equivalent to the various specialty groups in this country, plus public health and Japanese governmental agencies, the meeting was marked by presentation of about 200 papers by Japanese scientists and by some invited guests from other countries.

The Fourteenth Congress is the first meeting to have a Proceedings prepared in English. It affords an excellent opportunity for those interested to see the progress taking place in Japanese medicine and related fields. Only a few examples can be cited. In the area of cardiac surgery research it is impressive to see that Sakakibara of Tokyo Women Medical College has developed a cardioscope which permits, for the first time, photographing of the valve action from within the cardiac chambers. In endocrinology, Ogata has suggested that an active principle which he has isolated in crystalline form (parotin) from the parotid gland will prevent chondrodystrophia foetalis and Kashin-Beck disease. In epidemiology, further work has been carried out on scrub typhus (Tsutsugamushi fever) in Japan. At least 60 species of mites now are indicted as vectors. Antibiotic therapy shows promise here. Beautiful electron microscope plates illustrate the effect of a phage altering the structure of an infected bacterium cell.

The field of radiology is growing. Cobalt 60 and other radioactive isotopes are available for investigation in Japan. The reviewer found that nearly every department of the basic sciences and of the specialty areas in medicine and surgery was represented by some interesting communication.

The Proceedings reveal that the Japanese scientific mind is active in many directions and that there is much productive and original thought coming from this source. The Japanese have problems and they are gathering information about them. Some of the data on these oriental matters are intriguing. Heroin addiction, for example, is increasing in Japan among young people. In the professions, 758 medical practioners are listed as addicts compared to 344 prostitutes. While infant mortality has been reduced, only 2.7 per cent of the total Japanese population lives beyond the age of 70, less than one-half the number expected in western countries. Better diet, especially soya beans and fish, seems to be associated with longevity in some villages. Where seaweed is eaten daily, the incidence of cerebral hemorrhage is low. Saki consumption does not appear to influence longevity. All phases of nutrition are under study. A symposium was presented on ekiri, a disease in Japanese children which may be related to a dysentery toxin. Numerous other fascinating subjects are covered.

This book should be read with interest by those who would be aware of the work of these men devoted to the science of life and health. Through united effort comes the most definite progress in our attempts to make a better world.

ROBERT G. LOVELL, M.D.

ANALYTICAL PATHOLOGY; TREATISES IN THE PERSPECTIVE OF BIOLOGY, CHEMISTRY, AND PHYSICS. Edited by Robert C. Mellors, M.D., Ph.D., Associate, Pathology Division, Sloan-Kettering Institute for Cancer Research; Assistant Pathologist, Memorial Center for Cancer and Allied Diseases; and Assistant Professor of Pathology, Cornell University Medical College, Sloan-Kettering Division, New York. Cloth. Price, $12.00. Pp. 477, with figures and tables. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, New York, 1957.

This volume is a collection of monographs on recent advances in the study of the pathogenesis of disease. As stated by Dr. E. L. Opie in the foreword, "In the monographs that make up

this volume, pathology has assumed the broad meaning rightly attributed to it." It breaks away from the well-trodden paths of morphologic pathology to illustrate graphically the physical, chemical and biologic correlation with disease processes. It is compiled in a fashion similar to Mellors' book on "Analytical Cytology" published in 1955, and it has maintained the same high standards.

The sections of the book are: "Cancer—Biology, Biochemistry and Pathology" (Robert C. Mellors, M.D., Ph.D.); "Cardiovascular System—Arteriosclerosis and Hypertension" (John W. Gofman, M.D., Ph.D.); "The Kidney—Inflammatory and Vascular Disease of the Glomerulus" (David B. Jones, M.D.); "The Liver—Three Aspects of Hepatic Failure: Cholemia, Ascites, and Hemorrhagic Phenomena" (Oscar D. Ratnoff, M.D.); "The Endocrine System—The Adenohypophysis" (Agnes B. Russfield, M.D., Ph.D.); "The Hematopoietic System"—I. Macrocytic Anemias (John F. Mueller, M.D., and Richard W. Vilter, M.D.) and II. Abnormal Hemoglobins (John J. Will, M.D.); "Hypersensitivity—The Role of the Connective Tissue" (Bernard M. Wagner, M.D.).

These reviews of recent research in the fields covered are supplemented by 70 clear black-and-white photographs and comprehensive bibliographies. The indexing system is considerably improved over that of the companion book. The volume affords an excellent opportunity to review the fundamentals of dynamic pathology through the contributions of biology, chemistry, and physics, and it represents an important contribution to medical literature.

Edwin M. Knights, Jr., M.D.

IIe Congrés International de Radiophotographie Médicale. Paris—4–7 Avril, 1956. Rapports. Paper. Price, 2,500 fr. Pp. 356, with figures and tables. Masson et Cie, Éditeurs, 120 boulevard Saint-Germain, Paris-6e, 1956.

This book is a compilation of papers in Italian, French, English, and German regarding the technical and diagnostic features of mass chest roentgenography as presented at the Second International Congress on medical photoroentgenology. Photoroentgenology as practiced in Europe and the British Isles is clearly evaluated by recognized authorities. Its usefulness in the detection of tuberculosis, pulmonary cancer and pneumoconiosis is authoritatively discussed with numerous and impressive statistics. The importance of observer error in the interpretation of the photoroentgenograms and the means for correction are pointed out.

The technique of photoroentgenography is described, and many excellent recommendations for improving the diagnostic qualities of photoroentgenograms are made. Among them are the use of the concentric mirror optical system of exposure and the control of secondary radiation and its bearing on quality. The advantages of the lateral view in photoroentgenography are cited, the most pertinent being better visualization of the soft tissues because of the elimination of some of the superimposed bone images that are seen in the posteroanterior views. Also, trespass of tumor masses or cardiac abnormalities into the mediastinal spaces can be more readily detected.

Among the papers written in English are titles referring to mass photoroentgenography in countries with low tuberculosis morbidity, case findings of cardiovascular diseases and bronchial carcinoma, standardization of photoroentgenographic techniques, interpretation, and hospital photoroentgenography.

Arthur W. Fuchs

Basic Foundations of Isotope Technique for Technicians. Edited by Willard C. Smullen, M.D., F.A.C.R., Radiologist in Charge, St. Mary's Hospital, Decatur, Illinois. Cloth. Price $4.75. Pp. 163, with 54 illustrations. Charles C Thomas, 301 East Lawrence Avenue, Springfield, Illinois, 1957.

This small text, a collection of material prepared for a training program for technicians, offers a concise presentation of the basic concepts relating to medical isotope usage. The book is not highly technical by design, since its use is primarily intended for those with a relatively limited background. Its simplicity, however, has made it the more valuable in presenting a compendium of these rather new techniques.

Aebersold, one of several contributors, discusses the place of the technician in the radioisotope program in an excellent introductory chapter. His presentation places the technical aspects of the use of radioisotopes in medicine in good perspective. Durlacher presents the physical foundations of radioactivity in the second chapter with clarity and sufficient emphasis to give the tyro technician a good start

in the field. The third chapter, using descriptions, diagrams and photographs, classifies the basic instrumentation needed for modern isotope work. The problems of personnel protection from various types of radiation are next discussed. In each case there is a description of the technical apparatus required, as well as the physical basis for such considerations.

Little then describes the diagnostic use of radioiodine and Smullen presents the therapeutic use of this agent. Both of these chapters are extraordinarily well written and present the current use of radioiodine objectively with due consideration for other established methods. Ross outlines the use of P^{32} in its physiologic, diagnostic and therapeutic aspects. The use of radioactive gold is next explained by Cook and its use is particularly compared with colloidal chromic phosphate. He concludes that the use of colloidal chromic phosphate will probably replace gold in the treatment of serous effusions and that gold will be used primarily in the form of seeds. Tabern then discusses other diagnostic and analytic procedures employing radioisotope techniques. These include blood volume, circulation time, pancreatic function determinations and brain tumor localizations, all using iodinated human serum albumin. The iodine-tagged fat study is another of the principal applications at this time. Hematologic investigation with radioactive chromium and the use of radio-iron in deficiency anemias is described. The cobalt^{60} labeled vitamin B_{12} test for pernicious anemia is also included. The use of I^{131} labeled rose bengal as a test of liver function, as well as other less commonly used diagnostic procedures, is presented. This contributor also considers the methods and procedures involved in the procurement and use of radiopharmaceuticals.

The Atomic Energy Commission requirements for experience in training are tabulated. Glossaries of nuclear particles and pertinent physical terms are appended. Logarithmic decay curves and lists of routine diagnostic and therapeutic procedures, as well as the more commonly used isotopes, comprise another appendix.

This excellent text which is designed for the use of technicians could be profitably read by interested nurses and residents, as well as other physicians, for a well-oriented introduction to the use of radioisotopes in medicine.

K. L. Krabbenhoft, M.D.

Medical Effects of the Atomic Bomb in Japan. Edited by Ashley W. Oughterson, Clinical Professor of Surgery, Yale University School of Medicine, and Attending Surgeon, Grace-New Haven Community Hospital; and Shields Warren, Pathologist, New England Deaconess Hospital, and Professor of Pathology, Harvard Medical School. Cloth. Price, $8.00. Pp. 477, with numerous figures. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York, New York, 1956.

This volume presents the findings of the Joint Commission for the Investigation of the Effects of the Atomic Bomb in Japan, which began field studies in Nagasaki seven weeks after the bombing, and in Hiroshima nine weeks after the bombing. The accumulated and analyzed data consist of (1) clinical and autopsy material made available to the Joint Commission by the Japanese, (2) reports of Japanese research groups, (3) clinical observations of hospitalized and clinic patients, and (4) results of a "sampling study."

The first several chapters give the historical background, provide a brief orientation on atomic warfare, and discuss the scope of damage of the atomic bombs and the effects on medical care and facilities. The important factors of population density, distance from the explosion and amount of shielding are carefully considered in relation to casualty production. The casualties are classified according to their causes: blast, heat and/or ionizing radiation. Various incidence tables and mortality data are included. The frequency, time of onset and duration of significant signs and symptoms are interrelated and correlated with other clinical and laboratory data, with distance of exposure and with degree of shielding.

The hematology of atomic bomb injuries is considered and the "broad features of changes in the blood caused by exposure to ionizing radiation" are noted. The discussion deals mainly "with counts and with the general pattern of the response as observed with the passage of time." The nature and sequence of changes in the bone marrow following exposure to lethal and sublethal doses of ionizing radiation are described.

The chapter on pathology of atomic bomb injuries contains for the most part material that had been published previously (*Am. J. Path.* 1949, *25*, 853–1027). The significant anatomic findings are described in relation to primary

grouping (time of death) and secondary grouping (severe burns and distance of exposure).

This important compilation documents the immediate acute medical effects of the atomic bombs in Nagasaki and Hiroshima (from time of exposure to several months afterwards). The text is well supplemented by reproductions of photographs of both historical and scientific value. A concise discussion of the methodology is given in the appendices. In the summaries of the studies, the effects of the bombing of the two cities are compared. This book represents Volume 8, Division 8 of the National Nuclear Energy Series.

Wataru W. Sutow, M.D.

Röntgenologische Differentialdiagnose der Knochenerkrankungen. By Dr. Hans Hellner, O. Professor für Chirurgie, Direktor der Chir. Univ.-Klinik, Göttingen; und Dr. Hanno Poppe, Facharzt für Röntgenologie, Leiter der Röntgen-Abteilung, der Chir. Univ.-Klinik, Göttingen. Cloth. Price, $64.30. Pp. 903, with 518 illustrations. Georg Thieme, Herdweg 63, Stuttgart, Germany, 1956.

This imposing volume represents the reproductions in the original negative of 842 roentgenograms from 500 patients, selected from a material of about 70,000 cases. These cases have been arranged to present the characteristic clinical and roentgenologic findings of diseases of the skeletal system from the point of view of differential diagnosis.

The authors state that the diversity of bone diseases imposes a certain limitation of material, and for this reason the large field of inflammatory bone diseases, the rarer infections and parasitic infections, the variations on anomalies and congenital malformations, as well as the multiplicity of reactive bone processes due to traumatism, have required considerable abridgment. The reader is referred to the excellent monographs and comprehensive textbooks on the subject.

The material in this book is restricted to concise text discussions essential for differential diagnosis, together with the exhibition of a large number of appropriate examples. Special attention and extensive space has been given to the consideration of benign and malignant tumors of bone. The reader will understand the importance of the earliest possible correct diagnosis, since an early diagnosis is the essential factor for necessary therapy. Particular emphasis has been placed on the roentgenologic findings themselves.

This is an excellent contribution to the literature of bone diseases and should find much favor among roentgenologists and orthopedists.

James T. Case, M.D.

BOOKS RECEIVED

Human Cancer; A Manual for Students and Physicians. By Maurice M. Black, M.D., Associate Professor of Pathology and Clinical Pathology, New York Medical College, Flower and Fifth Avenue Hospitals; and Francis D. Speer, M.D., F.C.A.P., Professor and Director, Department of Pathology and Clinical Pathology, New York Medical College, Flower and Fifth Avenue Hospitals. Cloth. Price, $7.50. Pp. 273, with figures and tables. Year Book Publishers, Inc., 200 E. Illinois Street, Chicago 11, Illinois, 1957.

Retropneumoperitoneum und Pneumomediastinum. By Prof. Dr. U. Cocchi, Zürich. Cloth. Price, DM 67.50. Pp. 226, with 142 illustrations. Georg Thieme, Herdweg 63, Stuttgart, Germany, 1957.

Guide to Medical Writing; A Practical Manual for Physicians, Dentists, Nurses, Pharmacists. By Henry A. Davidson, M.D., Editor, Journal of the Medical Society of New Jersey. Cloth. Price, $5.00. Pp. 338. The Ronald Press Company, 15 East 26th Street, New York 10, New York, 1957.

Clinical Use of Radioisotopes; A Manual of Technique. Edited by Theodore Fields, M.S., F.A C.R. (Assoc.), Assistant Director, Radioisotope Service, Veterans Administration Hospital, Hines, Illinois; and Lindon Seed, M.D., Clinical Associate Professor of Surgery, University of Illinois College of Medicine. Cloth. Price, $9.50. Pp. 455, with 71 illustrations and 35 tables. Year Book Publishers, Inc., 200 E. Illinois Street, Chicago 11, Illinois, 1957.

Die hüftnahen Femurosteotomien; Unter Berücksichtigung der Form, Funktion und Beanspruchung des Hüftgelenkes. By Priv.-Doz. Dr. M. E. Muller, Zürich. Cloth. Price, DM 49.50. Pp. 184, with 282 illustrations. Georg Thieme, Herdweg 63, Stuttgart, Germany, 1957.

Manual of Radiation Therapy. By K. Wilhelm Stenstrom, Ph.D., Professor of Biophysics, Director, Section of Radiation Therapy, University of Minnesota Medical School; collected by John B. Coleman, M.D., Clinical Instructor in Radiology, University of Minnesota Medical School; revised with additions and discussions by Paul C. Olfelt, M.D., Clinical Instructor in Radiology, University of Minnesota Medical School; and Frances Conklin, M.D. Cloth. Price, $4.50. Pp. 94. Charles C Thomas, Publisher, 301 East Lawrence Avenue, Springfield, Illinois, 1957.

Vol. 78, No. 1

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

Head

Griffiths, Trevor. Observations on cranial radiography in a series of intracranial tumours. *Brit. J. Radiol.*, Feb., 1957, *30*, 57–69. (From: South East Metropolitan Regional Neurosurgical Centre, The Brook Hospital, Shooters Hill Road, London S.E.18, England.)

In a paper presented before the British Institute of Radiology (March 15, 1956), the author reviews plain roentgenographic examinations of the skull of 625 patients with verified intracranial tumors. Plain roentgenograms of the skull continue to be an indispensable requisite in evaluation of tumors of the skull.

The author gives a perusal of the literature and presents the following classification:

Cranial and Intracranial Tumors

1. Skull:
   - Osteoma
   - Chondroma, Chondrosarcoma, Hemangioma
2. Meninges:
   - Meningioma
   - Sarcomatosis, Carinomatosis, Melanomatosis, Lipoma, Gliosis
3. Nerve root tumors:
   - Neurinoma (Acoustic and Trigeminal)
   - Central Form of Von Recklinghausen's Neurofibromatosis
4. Tumors arising from vascular tissues:
   - Congenital Maldevelopments (Hamartomas)
   - True Tumors (Capillary Hemangioblastomas)
   - Papillomas of Choroid Plexus
5. Tumors arising from cerebral appendages:
   - Pineal-Pinealoma
   - Pituitary-Adenoma (Carcinoma)
6. Tumors arising from embryonic rests
   - Craniopharyngioma
   - Dermoid, Epidermoid and Teratoma
   - Colloid Cyst of 3rd Ventricle
   - Chordoma
7. Tumors arising from the brain itself:
   - Gliomas
     - Astrocytoma Grades I, II, III, IV
     - Ependymoma
     - Oligodendroglioma
     - Medulloblastoma
     - (Neuroastrocytoma)
8. Metastatic tumors

Of 625 cases examined, the plain roentgenogram gave definite evidence of intracranial tumors in 282 cases and in 87 cases it was strongly suggestive.

Because physicians at the present time are more brain tumor conscious than they were a generation or so ago, patients are referred earlier to neurosurgeons and the diagnosis is made at a much earlier stage, and, likewise, treatment is administered earlier.

In studying the plain roentgenogram of the skull, careful consideration and evaluation of the following 8 areas are of basic importance: (1) The Sella turcica —involvement of this is considered the most frequent and sensitive roentgenologic index of increased intracranial pressure. The appearance of the sella should be further evaluated as to whether the changes are due to conditions arising within, adjacent to, or remote from the sella. (2) Pineal displacement—this is the second most helpful sign and occurs half as often as the sellar changes. The pineal gland calcifies approximately in 50 per cent of adults and in less than 20 per cent of adolescents, and rarely in children. In an absolutely symmetric skull, accurately positioned, slight deviation from the sagittal plane should be considered pathologic. (3) Displacement of the choroid plexus—in adults these plexuses are calcified less frequently than the pineal gland. Slight asymmetry is not significant, but gross asymmetry is always pathologic. This, however, is rare. (4) Displacement of the falx cerebri—this is rare and can be demonstrated only when there is marked cerebral swelling and calcification of the falx. (5) Vascular markings—changes in the vascular grooves and channels in the skull have 2 main but different causes; (a) prolonged increased intracranial pressure which is not specific, and (b) increased blood requirements of a tumor, which depends on the specific type of tumor involved. (6) Pathologic calcifications —(exclusive of nontumorous calcifications) the incidence of calcification in proven gliomas as reported in the literature is approximately 10 to 11 per cent. (7) Arteriovenous malformation—the most common form of blood vessel tumor of the brain is congenital arteriovenous malformation. In the order of frequency, the location is in the anterior, middle and posterior fossa of the skull, best demonstrated by angiography. Calcification is an inconstant and inadequate diagnostic sign. (8) Metastatic tumors—91 cases of metastatic tumors of the skull were noted, of which 40 had concomitant chest involvement. In many of these a bronchial neoplasm was demonstrated at autopsy which was not suspected on the chest roentgenogram.

Noteworthy in the author's series is the fact that in the whole group of primary tumors, abnormality of the pituitary fossa was twice as frequent as pineal displacement, while the opposite was true in the case of cerebral metastasis.

Four tables and 18 figures accompany this excellent presentation.—*William H. Shehadi, M.D.*

Fischgold, H., Simon, J., and Metzger, J. Exploration radiographique des séquelles oculo-neurologiques post-traumatiques. (Radiologic investigation of the oculo-neurologic sequelae due to trauma.) *J. de radiol. et*

d'électrol. & Arch. d'électric. méd., Sept.-Oct., 1956, *37*, 750–763. (From: Clinique Neurochirurgicale et Neuroradiologie de la Pitié, Paris, France.)

The usual roentgenological examination of the orbit and its environment includes anteroposterior, nose-chin, lateral, and vertex roentgenograms. For the study of the orbit after trauma, further examination is necessary including standard views of the optic canal; laminagraphy planned to identify the many walls, septa, and clarity of the ethmoid-sphenoid mass; laminagraphy of the optic canal and magnified roentgenography in the Hartmann position to show the jugo-optico-clinoid line.

Many beautiful illustrations are included which are quite convincing that there is much return for meticulous and complete technique.—*Marcy L. Sussman, M.D.*

Neck and Chest

Bohlig, H. Zur Symmetrie des Röntgenbildes der Silikosen. (Symmetry of the roentgen image in silicosis.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, Jan., 1957, *86*, 10–17. (From: Radiumabteilung des Krankenhauses Meiningen, und Akademie für Sozialhygiene, Arbeitshygiene und ärztliche Fortbildung, Silikoseerhebungsstelle, Jena, Germany.)

Silicosis is characterized as a disease in which the typical distribution involves both lungs symmetrically. The chief basis for such a consideration is the equal content of dust in both lungs. However, detailed analysis of 131 cases of silicosis, among ceramists, stonecutters, and sand blasters, showed considerable variations between both lungs, especially when tabulating differences in density of lesions, size of strands or scars, and size of nodules occurring in each lung. A clear asymmetry was found in 21.5 per cent of the cases, with right-sided preponderance in 38 per cent.

It is difficult to give a scientific explanation for the right-sided predominance. The following suggestions, however, are offered: The vessels of the right lung are relatively hypoplastic compared to the left. Although silicosis orginally involves both lungs equally, poststenotic areas of emphysema develop differently in both lungs, and the result is an asymmetric pattern. The fact that the right lung has an extra interlobar fissure may play a role in asymmetry. The location of various, initial foci at or near the pleural surface will determine the end-appearance of a given lesion.

A true unilateral distribution of silicosis has not been confirmed. With the increased use of laminagraphy and "spot-film" techniques, the bilateral nature of the condition can often be identified in cases of apparent unilateral involvement. Even when the roentgenographic appearance was confined to unilateral involvement, pathologic examination disclosed the bilateral nature of the condition.—*J. Zausner, M.D.*

Mitchum, William R., and Brady, Boyer M. Differential diagnosis of fibrosing lung lesions. *Radiology*, Jan., 1957, *68*, 36–47. (Address: W. R. Mitchum, 5001 USAF Hospital, APO 731, Seattle, Wash.)

Differential diagnosis of fibrosing lung lesions is dependent on a correlation of clinical, roentgenologic, physiologic, laboratory, and pathologic findings. The conditions which produce shadows simulating pulmonary fibrosis are numerous, but systematic study of all structures seen on a chest roentgenogram will often help in making a diagnosis. Serial and multiple roentgenograms are needed to establish the pattern, distribution and symmetry of the fibrotic appearance. Fluoroscopic study of diaphragmatic and mediastinal movement is of considerable value.

Pulmonary hemosiderosis is almost invariably accompanied by hemoptysis and the characteristic roentgen features of mitral stenosis. It may be confused with miliary tuberculosis, simple pulmonary congestion, Boeck's sarcoid, pneumoconiosis and carcinomatosis. Hemosiderin deposits do not directly affect pulmonary functions. The pulmonary lesions remain quite constant over a long period of time.

Diffuse metastatic carcinoma of the lung is secondary to only a few primary lesions, chiefly in the stomach, lung, pancreas, breast, colon, and gallbladder. Tumor cells may reach the lungs by a hematogenous or lymphogenous route. The hematogenous type of disease is evenly and diffusely distributed through both lungs. The lymphogenous type produces a fine fibrotic appearance with fibrotic strands branching out from the hilus and nodules of varying sizes along the course of the fibrotic strands. Hilar lymph node enlargement may be present.

Idiopathic pulmonary fibrosis is a progressive disease characterized by an acute onset with dyspnea, cough, and sometimes cyanosis. Pulmonary function is impaired. In the early stages, there is prominence of the lung markings, and some small nodules superimposed on the fibrous network. In late stages, nodules may become confluent, fibrous strands are prominent, and areas of emphysema are present.

Boeck's sarcoid produces changes in the intrathoracic lymph nodes and the pulmonary markings. Lung findings are variable as to extent, character and location. Peripheral lymph node enlargement, bone changes, liver and spleen hypertrophy, eye changes, and lacrimal and salivary gland involvement occur in varying degree.

Other conditions which are associated with pulmonary fibrosis include rheumatoid arthritis, bronchiectasis and scleroderma. Pulmonary changes fol

lowing roentgen therapy vary from pneumonitis to fibrosis. Inhalation disease is another cause of pulmonary fibrosis, but it is emphasized that too many diagnoses of pneumonoconiosis have been made because of an abnormal chest roentgenogram, plus an occupational history.

It is concluded that there are few instances when the radiologist can be sure of the etiology of a fibrotic appearance on chest roentgenograms without additional information.—*A. W. Sommer, M.D.*

Voluter, G. Épisodes radiologiques de la perforation ganglio-bronchique au cours de la primo-infection. (Radiologic aspects of perforation of the bronchial lymph nodes in the course of the primary infection.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, Sept.-Oct., 1956, *37*, 738–749. (From: Laboratoire de Radiomorphologie de l'Institut pathologique de l'Université, Geneva, Switzerland.)

There are direct and indirect signs of intrabronchial performation of a caseous lymph node during a primary infection. The direct signs depend on the size of the perforation. In the prodromal phase, there is a wedge-shaped veil due to atelectasis with homolateral displacement of the mediastinum. This is followed by bronchial inundation with caseous material and the atelectasis is replaced by infiltrations. The latter is first homogeneous, then nodular and followed by cavitation which may be seen to communicate with a cavity in the lymph node. This is followed by stabilization with disappearance of the cavity and regression of the nodular infiltration. Finally there is nodular sclerosis with scarring in the hilar area and calcifications.

The indirect signs are infiltrations far from the hilus and having no connection with the lymphatic drainage, a micronodular infiltrate due to small fistulas and a syndrome of pseudomiliary sensitization.—*Marcy L. Sussman, M.D.*

Dennis, John M., and Boudreau, Robert P. Pleuropulmonary tularemia: Its roentgen manifestations. *Radiology*, Jan., 1957, *68*, 25–30. (Address: J. M. Dennis, University Hospital, Baltimore 1, Md.)

Pulmonary and pleural involvement in tularemia occur more commonly than was formerly believed, and, since early diagnosis and specific therapy are important in reducing morbidity and mortality, its prompt diagnosis is of utmost importance. While not specific, the roentgen manifestations are such that the diagnosis of tularemia may be suggested early in the course of the disease.

There are 3 main clinical forms of tularemia: (a) ulceroglandular, (b) oculoglandular, and (c) typhoidal. Pneumonia may occur in each of these, secondary to a bacteremia, but is encountered much more frequently in the typhoidal form of the disease.

Fourteen cases of tularemia with pleuropulmonary involvement demonstrated roentgenologically are discussed. This involvement varied from a stringy peribronchial infiltration to one of homogeneous density with lobular distribution. The latter type of finding was far more prevalent. The infiltration was found to vary greatly in location and extent with a bilateral process in 5 patients and a diffuse involvement scattered throughout both lungs in 3. Three other patients showed a homogeneous infiltration which appeared as a spherical density described as typical of tularemic pneumonia. Hilar and mediastinal adenopathy was present in 3 cases. It is believed that peribronchial infiltration is the earliest roentgen manifestation of pulmonary involvement, since, in some instances, it has been seen to progress to a lobular homogeneous consolidation.

Characteristically, there was almost always a tendency for the resolution of the infiltration to lag well behind the prompt clinical response to specific therapy. Pleural involvement occurred in 9 of the 14 patients, varying from a slight thickening of an interlobar septum to an extensive effusion. In most instances the effusion was slight, but it was always bilateral when the parenchymal involvement was bilateral.

Since the development of serum agglutinin against *P. tularensis* usually does not appear until one to two weeks after inoculation, the above findings in a patient who gives a history of having handled wild rabbits or rodents, or having eaten wild rabbits, or of having been bitten by a tick, may suggest the diagnosis early in the course of the disease and permit early specific therapy.—*Donald N. Dysart, M.D.*

Lodin, Herman. Roentgen diagnosis of pulmonary mycoma. *Acta radiol.*, Jan., 1957, *47*, 23–28. (From: Roentgen Department, University Hospital, Uppsala, Sweden.)

Mycoma is a strictly delimited, commonly solitary, tumor-like change caused by fungal infection. There is difference of opinion regarding whether the fungal infection is the primary pathology or whether the fungus is saprophytic and the fungal infection is localized to existing healed or partly healed lesions of the lung, notably abscess, bronchiectasis, and cysts.

The typical roentgenologic appearance is a hemogenuous, ball-like, mobile opacity seen lying in a thin-walled cavity and connected by means of one or more bronchi to the bronchial tree. The central opacity is surrounded by a thin crescent of air and may contain calcium. The central mass is composed of matted mycelia. The typical roentgenologic appearances are strongly diagnostic. In differential diagnosis tuberculoma and lung abscesses are the principal problems.

Four cases are reported.—*Lois Cowan Collins, M.D.*

GUNDERSEN, GUNNAR A. and NICE, CHARLES M., JR. Nocardiosis; a case report and brief review of the literature. *Radiology*, Jan., 1957, *68*, 31–35. (Address: G. A. Gundersen, University of Minnesota Hospitals, Minneapolis 14, Minn.)

The literature of nocardiosis is briefly reviewed and the clinical course and roentgenographic findings of a five and one-half year old boy who probably had nocardiosis for all but the first weeks of life are presented.

Nocardiosis in man can be caused by any one of nine species of Nocardia, but, in North America, *N. asteroides* is the usual agent. This species causes an acute lung infection, which becomes chronic and has a tendency to spread to other organs. The lung infection is manifested by malaise, weight loss, afternoon fever, and mucoid sputum. The infection commonly metastasizes to the brain as well as to the subcutaneous tissues. In the foot a small nodule forms which ulcerates and fails to heal. The infection often burrows into deeper structures to involve bone, and abscesses develop with the production of multiple draining sinus tracts. Roentgenographically the lungs may show either small infiltrates or large lobular consolidations with more frequent involvement of the lower lobes. Despite active disease, fever may not be present. Many patients show leukocytosis which aids in differentiation from tuberculosis and neoplasm. Early diagnosis is important as appropriate antimicrobial therapy, specifically the sulfonamides, appear to halt and perhaps heal nocardiosis. This disease should be considered when a relatively healthy appearing child has extensive lung infection demonstrable roentgenographically, with pustules appearing on the skin shortly thereafter.—*Harold C. Hamilton, M.D.*

NORDENSTRÖM, BJÖRN, FIGLEY, MELVIN, and SLOAN, HERBERT. Controlled puncture and contrast injection into the left ventricle of the heart. *Acta radiol.*, Jan., 1957, *47*, 33–45. (From: Department of Radiology and Section of Thoracic Surgery, University Hospital, Ann Arbor, Mich.)

A technique for controlled puncture and contrast injection into the left ventricle has been developed on the basis of 25 experiments in 16 dogs. The needle used had a closed tip with 8 small holes drilled perpendicular to the long axis of the needle near the obturated tip. The distance between proximal and distal holes is 2 mm., and the total area of holes is somewhat greater than the cross section area of the lumen of the needle (No. 16 gauge). The tip of the needle is sharp, allowing penetration of the heart without displacement, but the edges of the tip are rounded to avoid lacerating the heart. The obturated needle tip avoids punching out tissue which might otherwise be introduced into the ventricle. The multiple holes diminish the possibility of local damage to the endocardium which might occur with a single forceful jet, and also the multiple jets provide better mixing of contrast material and blood.

Anteroposterior and lateral roentgenograms are used for selection of the point in the heart to which the tip is to be guided, and the direction and depth of puncture are calculated by triangulation methods in reference to points obtained by placing a centimeter scale of lead below the xiphoid. The distances and angles are calculated on paper before injecting the diagnostic dose of contrast material, and 2 metal protractors indicating the calculated direction of the needle are attached to stands placed over the animal. It is felt that this precise control of the introduction of the needle diminishes the hazard of intramyocardial injection.

Before injecting the diagnostic dose of contrast material, a test injection of a small amount of saline is made rapidly. If the needle is not properly placed this produces extrasystoles. As a final check on the position of the needle, a few milliliters of contrast material is injected manually during exposure of a single roentgenogram.

So far as could be determined, no harm resulted from leaving the needle in the ventricle during the time required for development of the roentgenogram. In some of the experiments, the needles were left in place for a second injection for intervals of up to thirty minutes in length.

These experiments were conducted with simultaneous electrocardiographic and pressure recordings. In most instances, no disturbances in rhythm occurred. If electrocardiographic disturbances were produced, the needle position was adjusted.

The use of electrocardiographic and roentgenographic control of test injections assures the correctness of needle puncture and thus avoids the danger of intramyocardial or intrapericardial injection of contrast material.—*Lois Cowan Collins, M.D.*

JACOBSON, GEORGE, SCHWARTZ, LEONARD H., and SUSSMAN, MARCY L. Radiographic estimation of pulmonary artery pressure in mitral valvular disease. *Radiology*, Jan., 1957, *68*, 15–24. (Address: G. Jacobson, 1200 N. State St., Los Angeles 33, Calif.)

Surgery to relieve mitral stenosis is becoming a more common procedure as techniques for operating on the heart are being perfected. This procedure, however, should not be attempted in mitral valvular disease unless there is associated pulmonary hypertension.

Since the clinical diagnosis of pulmonary hypertension is difficult, this study was undertaken to determine whether a clinically useful correlation could be established between the size of the pulmonary artery and its major branches, as seen roentgeno-

graphically, and the pulmonary artery pressure. As cardiac catheterization is often the only way to determine definitely what the pulmonary artery pressure is, it was felt that if a better idea of this pressure could be obtained from the size of the pulmonary artery and its major branches (PAS) from the roentgenogram, catheterization might be avoided in some cases.

One hundred and twenty-four patients, with proved rheumatic heart disease with mitral stenosis, all of whom had cardiac catheterization to determine pulmonary artery pressures, were studied. Posteroanterior roentgenograms of the chest were evaluated and the appearance of the PAS was classified into 3 grades: Grade 1, normal or slightly enlarged; Grade 2, moderately enlarged; Grade 3, markedly enlarged.

The pulmonary artery pressures were also divided into 3 groups: Group I, 0–50 mm. Hg; Group II, 51–90 mm. Hg; Group III, above 90 mm. Hg.

The best correlation between the size of the PAS and the actual measured pulmonary artery pressure was found in PAS Grade 1, where 85 per cent of the cases were in the pressure Group 1. The larger the PAS or the higher the pulmonary artery pressure, the poorer the correlation between the two.

Hence, the authors conclude that if the sole purpose of cardiac catheterization is to determine pulmonary pressure, it is probably an unnecessary procedure when enlargement of the pulmonary artery segment is moderate or marked, since almost all of the patients will have significant pulmonary hypertension. When the pulmonary artery segment is normal, however, or just slightly enlarged, pulmonary hypertension can be excluded only by cardiac catheterization.

A discussion of the pathogenesis of pulmonary hypertension is also presented.—*Donald N. Dysart, M.D.*

Keats, Theodore E., Kreis, Van Allen, and Simpson, Ellen. An evaluation of the roentgen manifestations of isolated ventricular septal defect. *Radiology*, Jan., 1957, *68*, 9–14. (From: The Department of Radiology, and the Vascular Research Laboratory of the University of California School of Medicine, San Francisco, Calif.)

Accumulated experience in the roentgen study of congenital heart disease has made possible a re-evaluation of previously established diagnostic criteria. The problems of differential diagnosis no longer are matters of academic interest only, but have connotations of practical surgical importance. In order to re-evaluate the roentgen signs of isolated ventricular septal defect and to determine which of these signs are of aid in differential diagnosis, the authors have studied the roentgenographic and electrocardiographic manifestations in 20 proved cases.

It was found that isolated ventricular septal defect produces roentgen signs varying widely in magnitude the degree apparently being dependent upon the size of the septal defect. Analysis of the data obtained from this study, indicates that the most characteristic roentgen appearance of isolated ventricular septal defect is a slightly or moderately enlarged heart with right ventricular enlargement and enlargement of the left ventricle and/or the left atrium. The pulmonary artery and its branches are increased in size, and there is commonly enlargement of the pulmonary veins as well.

Ventricular septal defect may be differentiated roentgenographically from atrial septal defect by the absence of left-sided cardiac enlargement in the latter condition, and from those cases of patent ductus arteriosus in which the aorta is enlarged. Such enlargment is rare in ventricular septal defect. —*A. R. Watson, M.D.*

Feinblatt, Theodore M., and Ferguson, Edgar A., Jr., Timed-disintegration capsules (tymcaps)—a further study ; an in vivo roentgenographic study, blood-level study and relief of anginal pain with pentaerythritol tetranitrate. *New England J. Med.*, Feb. 21, 1957, *256*, 331–335. (Address: T. M. Feinblatt, 150 Woodruff Ave., Brooklyn, N. Y.)

In a further study of timed-disintegration capsules, the disintegration pattern visualized *in vivo* by roentgenography was confirmed by periodic blood-level determinations of the drug and clinical responses. The medication used was Corovas Tymcaps (timed-disintegration capsules of pentaerythritol tetranitrate), which were administered to 20 patients suffering from chronic symptoms of angina pectoris. Comparison of the results showed that roentgen visualization of disintegration, blood-levels of pentaerythritol tetranitrate and the clinical response all agreed. The evidence of roentgenographic dispersal, continued consistently high blood levels, and continuing substantial reduction of pain showed continuing absorption and utilization of the pentaerythritol tetranitrate during the period from three to nine hours after administration.

The conclusion was reached that pentaerythritol tetranitrate administered in the form of timed-disintegration capsules can be evenly and consistently utilized for control of anginal pain. Corovas Tymcaps contain pentaerythritol tetranitrate 30 mg. The first quarter (7.5 mg.) of this medication is dispersed immediately; the second, third and fourth quarters, after three, six and nine hours, respectively. The preferred technique of administration is one capsule every twelve hours, taken on an empty stomach with an adequate amount of water. The suggested optimum time of administration is one capsule half an hour before breakfast and a second

capsule before the evening meal approximately twelve hours later.—*Author's Abstract*

FEINBERG, S. B. Posterior mediastinal hemangioma. *Radiology*, Jan., 1957, *68*, 90–93. (Address: 737 E. 22nd St., Minneapolis 4, Minn.)

Mediastinal hemangiomas are rare, only 19 such tumors having been reported up to 1955, and only 2 of these were located in the posterior mediastinum. These tumors are usually asymptomatic, being found on a routine chest roentgenogram. Symptoms, when they occur, are due to the size or location which produce compression on adjacent vital structures. The differential diagnosis includes the neurogenic tumors, neurofibroma, neurofibrosarcoma, and neuroblastoma. Enteric cysts should also be ruled out. Treatment is usually surgical.

The author reports a case of benign cavernous hemangiomas located in the posterior mediastinum. A unique roentgenographic feature was the virtual disappearance of the mass on repeated rotation, even though it was sharply delineated on anteroposterior and posteroanterior views. This is suggested as a possible differential diagnostic clue to differentiate it from the neurogenic tumors.—*Donald N. Dysart, M.D.*

ABDOMEN

ANDRÉN, LARS, and THEANDER, GEORG. Roentgenographic appearances of esophageal moniliasis. *Acta radiol.*, Oct., 1957, *46*, 571–574. (From: The Roentgendiagnostic Department, Malmö Allmänna Sjukhus, Malmö, Sweden.)

Severe infections with *Candida albicans* (*Monilia albicans*) have become more common in recent years, apparently due to the increased use of antibiotics and cortisone. Although the esophageal lesions due to this fungus have been observed endoscopically and at autopsy, their roentgenographic appearance has not previously been recorded.

The authors report 2 cases of esophageal moniliasis in adults. Both patients had a chronic illness with a history of leukopenia, long treatment with antibiotics, and short courses of medication with cortisone and ACTH. Both patients had oral thrush with difficulty in swallowing. One patient made a complete recovery, while the other died from monilial sepsis and was autopsied.

On roentgen examination the mucosa of the esophagus was very irregular and ragged and there were numerous indentations and protrusions. In the nonfatal case the longitudinal folds remained visible throughout the course of the illness and the esophagus remained distensible. The entire thoracic portion of the esophagus was involved. The roentgen abnormalities in the fatal case were more severe and the longitudinal folds were not visible. At autopsy the esophageal wall was thickened and the mucosa was lined with a friable whitish-yellow membrane. Ulcerations were present in the lower two thirds of the esophageal mucosa.

The roentgen appearance in the nonfatal case superficially resembled esophageal varices, but involvement of the entire thoracic esophagus did not cause any difficulty in the differential diagnosis. In the fatal case the roentgen abnormalities were so marked that they could not be confused with varices. Although both of the authors' cases had oral manifestations of moniliasis, they point out that these do not always occur, even in severe monilial infection, and in such instances roentgen examination of the esophagus might give the first clue as to the correct diagnosis.—*J. L. Williams, M.D.*

FREIDENFELD, HANS. A double contrast method for the roentgen examination of esophageal strictures. *Acta radiol.*, Sept., 1956, *46*, 499–506. (From: Roentgendiagnostic Department, Karolinska Sjukhuset, Stockholm, Sweden.)

By the use of barium alone, it is difficult to determine the length, caliber, and distensibility of an esophageal stricture.

The author describes a method for double contrast study where the patient is studied in the upright position and given 1 teaspoonful of sodium bicarbonate and tartaric acid in equal parts, which is immediately washed down with thin barium. Carbonic acid is formed and gives excellent double contrast of the pre- and poststenotic areas and in some cases distention of the stenotic segment. Several exposures are made to exclude changes due to contractions of the esophagus. This method is not used if deglutition is defective in young children, nor for strictures in the hypopharynx. One hundred and four cases were studied, with good results and no complications. Seventeen representative roentgenograms are included in this article.—*Earl Stanley, M.D.*

KENDIG, TOM A., GASPAR, MAX R., SECREST, PETTUS G., and SHACKFORD, B. C. Calcification in gastric carcinoma; case report. *Radiology*, Jan., 1957, *68*, 80–82. (Address: T. A. Kendig, 211 Cherry Ave., Long Beach, Calif.)

Calcification in gastric carcinoma is an extreme rarity. Batlan, in a recent review of the literature, recorded what appears to be the only case in the American literature. He was able to find 7 cases in the foreign literature, 5 of which appear to have been proved. In this article, the authors have reported an additional case, bringing the total to 9 and the number of proved cases to 7.

The patient in this case was a twenty-seven year

old white female, who entered the hospital with a complaint of pain in the abdomen of some months' duration. Roentgenologic examination revealed a mass in the wall of the stomach. Mottled calcification was noted in the mass. On operation, a mucoid carcinoma simplex was removed. Metastases were present in one regional lymph node. After surgery the patient did well for about two and one half years, at which time a routine gastrointestinal examination revealed recurrence of the amorphous mottled calcification in the medial part of the left upper quadrant of the abdomen. The patient was again operated upon, and the calcification was shown to be within recurrent tumor in the gastric stump,immediately proximal to the gastrojejunal stoma.

This case report is of interest in that it brings to our attention the possibility of calcification within a gastric carcinoma, adds a ninth reported case to the world literature, and presents the interesting feature of calcification within a recurrence of the tumor.—*A. Ralph Watson, M.D.*

Friedmann, Asa B. Diverticula of the appendix; a case report. *Radiology*, Jan., 1957, *68*, 86. (Address: 50 Riverside Drive, New York 24, N. Y.)

A case of diverticula of the vermiform appendix is reported. The diverticula were an incidental finding and bore no relation to the patient's symptoms. Maissa found only a single case of diverticula of the appendix in 10,000 serial examinations of the intestinal tract. The rarity of diverticula arising in the appendix suggests the need for recording this case in the literature.—*Harold C. Hamilton, M.D.*

Levene, George, and Kaufman, S. A. An improved technic for double contrast examination of the colon by the use of compressed carbon dioxide. *Radiology*, Jan., 1957, *68*, 83–85. (Address: G. Levene, Massachusetts Memorial Hospitals, Boston 18, Mass.)

A new method for double contrast study of the colon is presented, using compressed carbon dioxide instead of air. The authors believe that this procedure is more comfortable for the patient and more convenient for the radiologist.

The method consists of a preliminary barium enema study and evacuation of the barium. The patient is again observed fluoroscopically and additional routine and spot roentgenograms are taken as indicated. A catheter is inserted into the rectum and carbon dioxide is allowed to flow into the bowel. The carbon dioxide is supplied by a small tank of the compressed gas, and the flow (1.0 to 1.5 liters per minute) is regulated by means of suitable valves. As a precautionary measure, the rate of flow must be regulated before the catheter is inserted into the rectum. During preliminary regulation, when the proper rate of flow is obtained, the gas supply is shut off by turning the main valve on the tank. The regulator on the reduction valve must not be disturbed. Filling of the colon with gas is observed fluoroscopically, and additional roentgenograms are made.

Advantages of the method are said to be rapid absorption of the carbon dioxide, the reduction of the risk of complications in case of accidental perforation of the intestine, the uniform and continuous flow of the gas as a result of a tank, and the complete elimination of the possibility of embolism.—*A. R. Watson, M.D.*

Andrén, Lars, and Frieberg, Sture. Spontaneous regression of polyps of the colon in children. *Acta radiol.*, Sept., 1956, *46*, 507–510. (From: Roentgen Department, Malmö Allmänna Sjukhus, Malmö, Sweden.)

Polyps occur in children especially in the four to six year-old age group, then decrease in frequency, and later increase in the twenty to thirty year-old age group.

The incidence of polyps in children is not definitely known, because few children outside the group presenting symptoms are ever examined for polyps.

Polyps do disappear, and the accepted explanation to date has been that they drop off.

The authors offer the additional explanation of spontaneous regression of polyps. Their theory is supported by 2 case reports of children in the five and six year-old age group, both with a history of rectal bleeding, in whom polyps were demonstrated by double contrast study. Follow-up studies after at least eighteen months showed regression in the size of the polyps. The children were free of symptoms in the interval between studies.

In view of the low incidence of malignancy in the colon of children, it would seem that surgical intervention should be more restrained.—*Earl Stanley, M.D.*

Peterhoff, Rome. Cholecystography with the sodium salt of iopanoic acid. *Acta radiol.*, Dec., 1956, *46*, 719–722. (From: Roentgendiagnostic Department, University Hospital of Lund, Lund, Sweden.)

The author reports on the result of 200 cholecystographies using bilijodon—natrium (sodium salt of iopanoic acid—sodium salt of telepaque). The advantage of this preparation is a lower incidence of opaque residues in the digestive tract. The quality of the cholecystogram is considered to be not inferior to that obtained when telepaque (iopanoic acid) is used.

The incidence of side reactions—nausea, vomiting, and diarrhea, is practically the same as with telepaque. The author makes no mention of bile duct visualization.

(Abstractor's note: This product was tested by us as well as other salts of iopanoic acid several years ago. Our observations are in accord with those reported by Dr. Peterhoff. However, in our series these salts gave practically no bile duct visualization and for this reason they were considered inadequate and were discarded. The biliary tract is considered as one unit—gallbladder and bile ducts, and should be visualized and evaluated as such, whenever possible.)—*William H. Shehadi, M.D.*

Lorenzo y Losada, H., Jr.; Caviglia Staricco, Enzo; Cerviño, J. M.; Arias Bellini, M.; Maggiolo, J.; de Buño, Rosa B.; and Mussio Fournier, J. C. Hypotonia of the gall bladder, of myxedematous origin. *J. Clin. Endocrinol. & Metabol.*, Jan., 1957, *17*, 133–142. (From: The Institute of Endocrinology, Hospital Pasteur, Montevideo, Uruguay.)

Since hypotonia of many of the visceral muscles has been described in myxedematous patients, the authors studied the function of the gallbaldder in 4 myxedematous individuals. The study consisted of timed duodenal drainage with an analysis of the quantities and types of bile, in conjunction with serial roentgenograms of the opacified gallbladder. In all 4 cases, there was evidence of retarded or deficient contraction of the gallbladder following stimulation by olive oil or magnesium sulphate. Following therapy with desiccated thyroid, the gallbladder contracted normally in all individuals. Both the illustrations and the text indicate that the gallbladder of each patient was normal in size or was only "slightly enlarged." Following treatment with desiccated thyroid, the size of the gallbladder in the resting state did not change, although the concentration of opaque medium in the gallbladder improved in 2 of the cases. The authors concluded that their evidence indicated hypotonia of the gallbladder in myxedematous patients.—*J. L. Williams, M.D.*

Macarini, N., and Oliva, L. Neue Wege zur Pankreasdarstellung. (A new method for demonstration of the pancreas.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, Jan., 1957, *86*, 55–65. (Address: N. Macarini, Istituto Radiologia Università, Ospedale S. Martino, Genova, Italy.)

Considerable information about the pancreas has been obtained by opacification of adjacent organs, thereby getting indirect roentgenographic evidence of pancreatic involvement. The authors have employed the simultaneous air-filled stomach and retroperitoneal air-insufflation for direct visualization of the pancreas. An equal mixture of tartaric acid and sodium bicarbonate (4 grams each) is used to inflate the stomach just prior to the introduction of air into the retroperitoneal space. For the latter, the conventional precoccygeal approach is used. Small children receive 200–300 cc. of oxygen; children from ten to fourteen years of age are given about 1000 cc.; and adults may need 1,400–1,800 cc. Left lateral laminagrams at 2 cm. intervals are made preferably with the patient in the erect position, in addition, transverse (coronal) laminagrams are made at the level including the second and third lumbar vertebral bodies.

The normal pancreas shows a sharp, smooth outline and allows free access to the air about its periphery; the size of the pancreas is compatible with the size of the individual. In pancreatitis, the viscus is enlarged, its outline is not sharp, and the retroperitoneal air has difficulty in uniformly surrounding the organ. In tumors of the pancreas, the border is irregular and lobulated; metastatic lymph nodes may be clearly identified by the contrasting air in the retroperitoneal space. Of course, a certain amount of experience with this method is required to be able to identify the normal size and normal variations in shape of the pancreas.—*J. Zausner, M.D.*

Gynecology and Obstetrics

Czyzewski, W. J. J. Hysterosalpingography using salpix; preliminary report. *Brit. J. Radiol.*, Dec., 1956, *29*, 679–681. (From: Oldchurch Hospital, Romford, Essex, England.)

In the search for an ideal contrast medium for hysterosalpingography, a considerable step forward has been made by the introduction of salpix. In recent years, 2 types of contrast media for this examination became firmly established, *i.e.*, iodized oils and aqueous solutions of organic compounds containing iodine.

The properties of an ideal contrast medium for hysterosalpingography are as follows: (1) It must be dense enough to give sufficient contrast; (2) it must possess sufficient viscosity to adhere to tubal walls so that their entire length is well outlined; (3) its flow through the tubes must be slow enough to permit adequate observation; and (4) its absorption and excretion must be complete within a few hours. Iodized oils fulfill most of these requirements; they do, however, present the following dangers: their absorption requires as long as three to six months; they may cause acute peritoneal reaction or give rise to oil retention cysts, acting in the peritoneum as foreign bodies; and there is always the danger of oil embolism. Although the aqueous solutions present no such dangers, their flow through the tubes is so rapid that peritoneal spill often occurs before an adequate series of roentgenograms can be secured. Consequently, the tubes are often obscured by the spill and their details cannot be recorded.

In salpix an adequate viscosity and tissue ad-

hesiveness together with sufficient radiopacity have been obtained. Salpix is a combination of a solution of polyvinylpyrrolidone (P.V.P.) and of sodium acetrizoate, an amber-colored fluid usually containing some crystals. It is stable at 50°C. for six months and does not lose its properties at 100°C. Moreover, it can be autoclaved, this process dissolving the crystals—which do not reform.

Extensive experiments on animals have shown interesting results, as follow: salpix injected intravenously leaves in a very short time by way of the kidneys; when injected into the uterus and spilled into the peritoneal cavity, it is absorbed and excreated by the kidneys within one or two hours; when injected subcutaneously or intraperitoneally it does not cause the slightest irritation to the tissues. It is of particular importance that accidental entry of salpix into the bloodstream has no harmful effect on the patient. The nontoxicity of salpix is explained as a property of polyvinylpyrrolidone, which directs the compound direct to the kidneys, thus accelerating excretion. Some authorities, however, are of the opinion that polyvinylpyrrolidone is retained in the reticuloendothelial system for an indefinite period of time; 1 (unpublished) work alleges that it may have carcinogenic action.

Meanwhile, one is bound to feel that pending further investigations, salpix may be used for hysterosalpingography with relative safety in view of the following circumstances: (1) Only a few cubic centimeters of polyvinylpyrrolidone are used and only 3–4 cc. arrive in the peritoneal cavity; (2) only a few cubic centimeters of P.V.P. per body weight are injected; and (3) the molecular weight of P.V.P. in salpix is well below the renal threshold value.

In a series of 60 cases, the following results were obtained: satisfactory filling of tubes and early spill, 31; tubes occluded, 24; equivocal results due to technical difficulties, 5; and spill still present after ninety minutes, 3.—*Fred D. Barlow, M.D.*

Bergman, Frank, Norman, Olof, and Sjöstedt, Sven. Perjodal H viscous, a water-soluble contrast medium containing dextran. *Acta radiol.*, Oct., 1956, *46*, 587–594. (From: Departments of Pathology, Roentgendiagnosis, Obstetrics and Gynecology, University of Lund, Lund, Sweden.)

Several substances have been tried for thickening water soluble contrast media for hysterosalpingography. The most widely used agents for increasing viscosity—oil, polyvinyl alcohol, and carboxymethylcellulose, are, however, far from ideal. Oil and carboxymethylcellulose often cause foreign body granulomas, and polyvinyl alcohol is likely to produce irritation. It had been suggested that dextran might be useful in thickening contrast media in hysterography. This suggestion was adopted and in 1952 dextran was added to perjodal (Pharmacia, Uppsala, Sweden), the product being called perjodal H viscous. Perjodal is a diodized pyridon, chemically identical with per-abrodil, umbradil, and diodrast. Perjodal H viscous consists of perjodal 35 per cent and about 30 per cent dextran. The molecular weight of the dextran used in the present investigation is somewhat lower than that of dextran generally used for infusion, since it has been observed that, in bronchography, the risk of granuloma caused by foreign body reaction decreases with the molecular weight of the colloid added.

Animal experiments using this contrast medium—injections being both intramuscularly and intrauterine—were done. In the animals sacrificed, after one week following the intramuscular injection, a marked foreign body reaction was observed at the site of injection. This reaction subsided in animals sacrified after two weeks, only secondary fibrosis being observed. In only 1 animal of 11 studied after one month or more, was a pathologic change noted. No reaction was observed after intrauterine injection in the actual tissue of the specimens removed. In one animal sacrificed after twenty days, a dextran-like substance mixed with polymorphonuclear leukocytes was found in the uterine cavity, but similar leukocytes were found in the lumen of the control side (rabbit) into which no contrast medium had been injected.

In the clinical trial, perjodal H viscous was used in more than 900 hysterosalpingographies, and 310 of these patients were afterwards operated upon. In 226 of this group, histologic examination of the tissues disclosed no evidence of foreign body reaction. In the remaining 84 cases, histologic examination revealed changes which might be ascribable to the contrast medium in 16 cases. A detailed analysis of these 16 cases showed: endometritis, 6 cases; myometritis, 1 case; salpingitis, 8 cases; granulomas, 5 in the uterus, 3 of the ovary, none in the tubes; some patients exhibited more than 1 of these conditions.

Results were interpreted as follows: As far as viscosity and opacity are concerned, perjodal H viscous proved satisfactory. It passes through the tubes slowly enough to allow detailed observation but readily enough to determine tubal patency. Immediate as well as late side-reactions were insignificant. No statement as to rate of absorption from the peritoneal cavity is made.—*Fred D. Barlow, M.D.*

Genitourinary System

Fontaine, R., Warter, P., Bilger, F., Kim, M., and Kieny, R. De l'intérêt de l'aortographie pour le diagnostic des affections rénales. (The significance of aortography in the diagnosis of renal lesions.) *J. de radiol. et d'électrol. & Arch. d'électric. méd.*, Sept.-Oct., 1956, *37*, 733–737. (Address: Pr R. Fontaine, Clinique Chirurgicale A., Strasbourg, France.)

The authors inject directly into the aorta at the level of D 12. Sometimes 2 needles are used, one on each side, with pressure to maintain a continuous flow. Ten cases are illustrated which include a demonstration of the arterial system in ptosis and ectopic kidney with renal artery rising just above the aortic bifurcation. Renal cyst is characterized by the vessels circumscribing the mass like an umbrella, while in cancer, the afferent artery is large, divides irregularly in the tumor and floods it. A case is described in which the vessels around a tumor mass were much smaller than on the healthy side; a cyst was found but there was also a tumor growing in contact with it. A tumor of the renal pelvis compromising the renal pedicle resulted in no visualization of the vessels or of the pelvis by intravenous pyelography.

Atrophic pyelonephritis, as well as tuberculosis, are characterized by poor blood supply. Angiography was also found useful in determining whether a hydronephrosis is due to an aberrant vessel.

In more than 200 of these aortograms, there was no serious accident.—*Marcy L. Sussman, M.D.*

Woodruff, John H., Jr., and Ottoman, Richard E. (Torrance, Calif.) Radiologic diagnosis of renal tumours by renal angiography. *J. Canad. A. Radiologists*, Dec., 1956, *7*, 54–58.

One hundred-thirty-seven aortographies were performed without a fatality, but the authors do not attempt to minimize the risk of renal angiography and they conclude that indiscriminate and routine use of this examination is not justified because of the risk.

Tumor vessels are described as being characterized by a disordered abundance with a variety of patterns. Several cases are illustrated and pyelographic as well as angiographic findings are shown. The authors believe that about nine of ten cortical carcinomas will show tumor vessels. They cite an example of diagnosis of a 1 cm. tumor with negative pyelograms and urograms.

Differentiation between renal tumors and cysts is not one hundred per cent accurate but the probability of error is reduced to a minimum. Perfection of technique, contrast material, and equipment should lead to a wider use of renal angiography in selected cases.—*Richard E. Kinzer, M.D.*

Eberl, J. Die Urinschichtung bei der i.v. Pyelographie. (Layering of the urine during intravenous pyelography.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, Jan., 1957, *86*, 74–78. (From: Institut und Poliklinik für Physikalische Therapie und Röntgenologie der Universität, Ziemssenstr. 1, München, Germany.)

With apparatus designed to simulate the anatomy and physiology of the excretory tract, it was discovered that the contrast material during intravenous pyelography does not form a true mixture with the urine. Layering, or separation between urine and contrast substance, is rarely seen in routine pyelography, since examination is not made with the patient in the erect position nor are transabdominal roentgenograms taken. Even with the latter exposures, it is quite impossible to demonstrate layering because the average renal pelvis has a volume of 2–5 cc. and the average excretion rate of the calyces is about 2–3 cc./min. Although the experiments indicated that "layering" should occur under normal conditions, it may be seen roentgenographically only when certain "favorable" factors coexist, namely, hydronephrosis with atony of the pelvis and a decrease in rate of diuresis.—*J. Zausner, M.D.*

Skeletal System

Sherman, Robert S., and Soong, Kenneth Y. Aneurysmal bone cyst: Its roentgen diagnosis. *Radiology*, Jan., 1957, *68*, 54–64. (Address: R. S. Sherman, Memorial Center, 444 E. 68th St., New York 21, N. Y.)

Forty-three aneurysmal bone cysts chosen from the files of Memorial Center, New York, were studied by the authors. All were histologically proved and adequate roentgenograms were available. This is the largest single series studied roentgenologically to date.

Aneurysmal bone cyst is a disease of adolescence, with its highest incidence between the ages of ten and nineteen years. Twenty-one (45.6 per cent) of the reported cases were in this age group. Nineteen patients were males and 24 females. The distribution of cysts in the skeleton in this series was as follows: long bones, 18; small tubular bones, 9; pelvis, 7; vertebral column, 6; mandible, 1; os calcis, 1; scapula 1.

Aneurysmal bone cysts present a varied roentgen appearance. The roentgen findings are influenced by the bone involved, the site of involvement, the age of the patient, the duration of the disease and the effect of treatment. The roentgen types found in the tubular bones were as follows: eccentric, 37 per cent; parosteal, 15 per cent; central, 48 per cent. The roentgen features displayed by the 10 "classical" lesions were eccentric position, diaphyseal location, ovoid configuration, and an expanded, ballooned-out, rarefied area containing fine and incomplete ridges or septa, producing a honeycomb appearance. The borders were well demarcated, with a thin layer of new bone in continuation with the expanded and thinned cortex. Except for location, the roentgen characteristics of the parosteal and the central diaphyseal types were like those of the eccentric type.

In the vertebral column the neural arch appeared to be the site of predilection. The lesions in the pelvic

bones were more varied in appearance. In some instances only irregular bone destruction was discernible. The full-blown reticulated ovoid calcified structure did not appear until later.

Surgical treatment varied from simple curettage to complete resection. Fourteen patients were treated by curettage and 8 by curettage plus the insertion of bone chips. Recurrences developed in 10 instances in this group. Roentgen therapy was given to 8 patients with a single failure. Tissue dose was in the neighborhood of 2,000 r in two weeks.—*A. W. Sommer, M.D.*

Guy, Roland, Raymond, Odilon, Samson, Roger, and Samson, J. Edouard. (Montreal, Quebec, Canada.) Aneurysmal bone cyst. *J. Canad. A. Radiologists*, Dec., 1956, *7*, 40–50.

Aneurysmal bone cyst has been defined by Lichtenstein as an entity characterized by a localized, solitary, distended, and lacunar lesion. The lesions are prone to produce bony trabeculae and thin calcified shells. When cut, one sees polycystic tissue where lacunae are filled with circulating blood. The soft tissue walls of the lacunae have a brownish red lattice-like appearance. Microscopically, the important features are the presence of blood channels and intermediary vascular and connective tissue. Primitive bone metaplasia with formation of osteoid tissue is a constant finding. The vascular lacunar system is filled with pure blood, but the walls have no true endothelium.

Two cases are reported by the authors and roentgenographic and microscopic findings are illustrated. Differential diagnosis is discussed in detail and it is pointed out that primary bone angioma, fibrous dysplasia, giant cell tumor, osteogenic fibroma, and even osteomyelitis must be considered.

Roentgenologic diagnosis is possible. The diaphyseal end of the shaft is involved in the long bones. The lesion is cystic, the cortex of the bone is destroyed and the thin periphery of the mass is usually lined with a thin shell of periosteal new bone. One must not mistake this appearance for osteogenic sarcoma because of the destruction and new bone formation. The vertebrae are involved in 25 per cent of cases and the lesions do not confine themselves to any particular part of a vertebra.—*Richard E. Kinzer, M.D.*

Wigby, Palmer E., and Thomas, John R. Spondylolisthesis: An autopsy study; preliminary report. *Radiology*, Jan., 1957, *68*, 94–99. (Address: P. E. Wigby, 506 Hermann Professional Bldg., Houston 25, Texas.)

Autopsy material pertaining to spondylolisthesis is being collected and the authors hope that after two or three years they will have something worth reporting. Serial microscopic sections of neural arches are being made in a search for bony defects, sites of weakness, unexpected ossification centers, nonunion of fractures, and other possible lesions. It is maintained that the pedicle clefts characteristic of spondylolisthesis are congenital in origin, though they may not actually be present at birth. It appears that normal childhood living produces a break or cleft in the congenitally narrow or weak isthmus. It is the opinion of the authors that this could be proved if enough fifth lumbar vertebrae could be examined at all ages up to about sixteen years.—*Harold C. Hamilton, M.D.*

Cornwell, William S., and Ramsey, George H. Unusual bilateral sacrococcygeal ossicles. *Radiology*, Jan., 1957, *68*, 70–73. (Address: W. S. Cornwell, 350 Westminster Road, Rochester 7, N. Y.)

Two well defined ossicles, one on either side of the sacrococcygeal articulation, in a male patient having some form of dysostosis are described. These ossicles were irregularly cylindrical with flattened ends, and each articulated superiorly with the corresponding lateral angle of the last sacral vertebra and inferiorly with the distal end of the first coccygeal transverse process. The possibilities of interpreting these 2 bones as unusual examples of ossified sacrococcygeal ligaments or of human coccygeal ribs are discussed.—*Harold C. Hamilton, M.D.*

Nitter, Lorentz. Three cases of eosinophilic granuloma of the pelvis in children. *Acta radiol.*, Dec., 1956, *46*, 731–740. (From: General Department, The Norwegian Radium Hospital, Oslo, Norway.)

The author gives a comprehensive review of the literature and presents 3 cases of eosinophilic granuloma of the pelvis observed since 1951 at the Norwegian Radium Hospital.

The ages of the patients were two and one half, one and one half, and two years respectively. Two were females and one was male. The chief complaint in all 3 cases was essentially pain in the leg, weakness and disability. In all 3 cases, a characteristic bone defect was noted in the pelvic bones. The diagnosis was confirmed by microscopic study of tissues removed.

In Cases 1 and 11, the lesion was solitary and occurred in the left iliac bone. Both were cured with roentgen therapy. In the third case, the initial lesion involved the right iliac bone with subsequent appearance of a second lesion in the contralateral side. The lesion was removed surgically, but recurrence was soon noted. This was followed by radiation therapy. When administered, in order to "protect" the ovaries, the roentgen beam was directed tangentially.

Serial roentgenograms accompany each case and

show the gradual disappearance of the defect with filling in of healthy bone tissue.—*William H. Shehadi, M.D.*

RODKO, E. A. (Vancouver, British Columbia, Canada.) Alkaptonuria with ochronosis and arthritis. *J. Canad. A. Radiologists*, Sept., 1956, *7*, 29–32.

Alkaptonuria is a result of an error of metabolism which is inherited. It occurs most often in males and is a recessive mendelian trait often occurring as a result of consanguinity.

The abnormal reducing material found in the urine has been called alkapton. Discoloration of the urine occurs after alkalinization or gradually on standing. Ochronosis is a brownish or blackish discoloration of cartilage, skin, etc., and is probably due to ectopic deposits of pigmented material normally present in lesser amounts. Pigmented spots are seen in the sclera, skin of eyelids, nose and cheeks. Deposits in the cartilage may cause induration and swelling of nose, ears and larynx. Arthritic symptoms are seen in about half of the cases. Alkaptonuria, ochronosia, and arthritis form a triad in these cases. The author presents a proven case and numerous excellent photographs and reproductions of roentgenograms are used to illustrate the findings. He points out that the arthritic findings may simulate both rheumatoid arthritis and osteoarthritis. Calcification of intervertebral disks in his case was pronounced in the lumbar area. Most of the other arthritic changes illustrated were characteristic degenerative changes. —*Richard E. Kinzer, M.D.*

MURRAY, R. O. Congenital indifference to pain; with special reference to skeletal changes. *Brit. J. Radiol.*, Jan., 1957, *30*, 2–6. (From: Royal National Orthopaedic Hospital, London W.1, England.)

The author discusses the condition of indifference to pain, whereby a stimulus which would be considered painful to a normal individual is not appreciated by another. This condition may be acquired (organic lesions in supramarginal gyrus, emotional states, drugs or prefrontal lobotomy) or congenital. In the congenital group, the children usually have an average mentality, but some may be below normal. The presenting symptoms are due most frequently to systemic infections or to deformity from an unattended injury which was painless because of the patient's indifference to pain.

The skeletal abnormalities fall into 3 groups: (1) Charcot joints; (2) fractures; and (3) osteomyelitis, which is a common complication due to neglect of open wounds. The mechanism of production of Charcot joints is discussed by the author and found fulfilled in congenital indifference to pain. Eloesser (1917) sectioned the posterior roots in 38 healthy cats and found 27 developed spontaneous fractures or dislocations. Of these, 27 Charcot joints developed in 8 animals when the fracture involved the joint. In 3 other cats, a joint was damaged after the limb had been made anesthetic and each of these developed Charcot changes in three weeks. Eloesser thereby concluded that these changes in the joints were due to trauma in the absence of a warning sense of pain. Charcot joints are well known in tertiary syphilis (usually lower extremity) and syringomyelia (usually upper extremity). In congenital indifference to pain, the ankle and joints of the tarsus are the most common sites for these lesions.

A case of an eight year old Arab male with complete indifference to injury and pain is added to the 11 cases of children in the first decade of life, previously reported in the literature. This child, when studied, had numerous old traumatic lesions involving the bones of the right and left ankle, both feet and right knee which were interpreted as arthropathies of a Charcot nature.

The author concludes that the presence of Charcot joints in a child should bring to mind the possibility of congenital indifference to pain. Also when this condition has been clinically established, a roentgenologic skeletal survey is indicated, as unsuspected bone lesions may be present.

The author feels that his findings in this condition coroborate the work of Eloesser (1917) concerning the etiology of Charcot joints. He also stresses the dangers of fracture treatment by plaster immobilization in cases of indifference to pain, as plaster sores or pressure areas, being painless, may go undetected until the cast is removed.—*William C. MacCarty, Jr., M.D.*

EPSTEIN, BERNARD S. Vertebral changes in childhood leukemia. *Radiology*, Jan., 1957, *68*, 65–69. (Address: Long Island Jewish Hospital, New Hyde Park, L. I., N. Y.)

The osseous changes produced by leukemia in children have long been recognized. Spinal involvement has not, however, received as much attention as the better recognized changes in the extremities. The author has, therefore, reported on the roentgenologic changes in the spines of 15 children with leukemia. The children varied in age from six months to fourteen years, and the duration of the disease ranged from about ten weeks to well over two years.

The roentgenographic changes noted in the vertebrae included diffuse demineralization of the bodies, the neural arches and the transverse processes. The loss of bone density appeared to be more pronounced in the thoracic and the upper lumbar spine.

In 6 of the children, this demineralization was greater in the centers of the vertebrae than at their peripheries. Varying degrees of compression of the vertebral bodies were observed, the most common structural change being anterior wedging. In some infants, the anterior venous sinuses in the middle

and lower thoracic vertebrae were widened. Thinning and breaking of the cortical margins were occasionally seen, but these features were better demonstrated on postmortem roentgenograms of vertebral slabs. Of particular interest were horizontal zones of radiolucency at the upper and lower aspects of the vertebral bodies, corresponding to similar zones at the ends of long bones.

Histologic studies in the 7 cases in which necropsy confirmation was available showed thinning of the bony trabeculae to the point of disappearance in scattered areas. The orderly arrangement of trabeculae was disturbed, with leukemic cells packed between them. The horizontal zones of radiolucency were ascribed to disruption of the normal chondro-osseous junctions by proliferating leukemic cells.—*A. Ralph Watson, M.D.*

Bohatirchuk, F. Aging and osteoarthritis. *Canad. M. A. J.*, 1957, *76*, 106–114. (From: Department of Anatomy, University of Ottawa, Ottawa, Ontario.)

To determine the appearance of bones in the normal aging process, as compared with the pathologic process, studies were carried out on 500 elderly persons, as well as 560 human skeletons and bones of aging animals. Individuals of both sexes, mostly over sixty, were studied. Hands and vertebral column were the principal subject of examination.

Two methods were used: (1) Macroradiography (roentgenography), and (2) historadiography (microroentgenography). In historadiography, roentgenograms are taken of bone slides with soft roentgen rays (10–12 kv.) and later studied under an ordinary microscope. This permits study of genuine undecalcified bone.

It was found that between 60 and 70 per cent of old people examined did not complain of any bone and joint ailments. Any minor symptoms were considered by them to be an attribute of their age. There were no obvious abnormalities on physical examination.

Macroradiography of this normal aging group revealed some roentgenographic signs which are divided into 2 categories: (1) atrophic (osteoporotic), and (2) hypertrophic.

The bone atrophy or osteoporotic category showed changes in roentgen-ray absorption consisting of moderate increase in bone transparency, which was quite conspicuous in the late sixth decade and reached its maximum in the late eighth decade; later on, the progress of atrophy was slowed. Harmonious development of atrophy and hypertrophy was present in the whole skeleton. Also changes in roentgen-ray morphology were noted, which consisted of thinning of compact bone, especially in areas of metaphysis and epiphysis; slight diminishing of trabeculae in spongy bone; sometimes small cavities in spongy bone.

The hypertrophic category exhibited increased absorption of roentgen rays in areas of hypertrophy and calcifications; harmonious development of hypertrophy in the whole skeleton; unevenness, roughness of bone outline; general enlargement of epiphysis and joint surface; appearance of small lippings and exostoses.

Historadiographs showed no considerable difference as regards to roentgen-ray absorption between adult and normally aging bone.

In contrast with normally aging signs, some of the old persons had roentgenographic changes in their bones and joints, which were considered pathologic. The majority of these were symptomatic. In these "symptomatic" persons, macroradiographs showed the following:

In bone atrophy there was advanced osteoporosis in earlier decades; faster progress of osteoporosis than in normal aging; disproportion between the development of atrophy and hypertrophy; excessive thinning of compact bone in whole bone, large cavities in spongy bone.

In bone hypertrophy there was disharmonious development of hypertrophy in the whole skeleton; unusual localization of exostosis in separate joints; irregular calcium deposits on the periphery of exostosis; excessive developing of lipping, complete or partial fusing of neighboring lippings; compression fractures; appearance of calcification inside bone; development of inordinate calcifications inside joint and in close vicinity to it.

Historadiographs showed: (1) Much more conspicuous bone declacification; (2) formation of large cavities; and (3) impregnation of cavities with calcium salts. All of the above atrophic and hypertrophic changes in both normally aging and osteoarthritic people were also found in dogs.

The similarity of aging changes in the bones of man and dog supports the views of those authors who consider hormonal disturbances in old age to be the principal cause of aging changes in tissues and organs, in particular those of the skeleton. It is felt that this research will help to relieve a normal old man from the psychologic burden of a diagnosis of osteoarthritis, whenever possible.—*William C. MacCarty, Jr., M.D.*

Daves, Marvin L., Gould, David M., and Schultze, Gunter. Roentgen findings in patients with high serum calcium. *Radiology*, Jan., 1957, *68*, 48–53. (Address: M. L. Daves, Department of Radiology, Johns Hopkins Hospital, Baltimore 5, Md.)

The roentgen findings in 75 patients with elevated serum calcium levels ranging from 11 to 18 mg. per cent were reviewed at the Johns Hopkins Hospital. The roentgenologic skeletal findings fell into 5 categories: (a) focal and disseminated lesions, usually lytic, observed in cases of myeloma, cancer of

the breast and lung, and miscellaneous neoplasms; (b) malacic lesions observed in cases of hyperparathyroidism and in 4 cases of undetermined etiology; (c) porosis observed in cases of thyrotoxicosis, hypervitaminosis D, Cushing's disease, postmenopausal osteoporosis, hyperparathyroidism, miscellaneous malignant lesions, and 3 cases of undetermined etiology; (d) changes characteristic of Paget's disease in which hypercalcemia may be a transient phenomenon when these patients are put at rest, as encountered in 1 case; and (e) absence of roentgen skeletal abnormalities encountered in cases of sarcoid hyperparathyroidism, thyrotoxicosis, cancer of the lung, leukemia, and 5 cases of undetermined etiology.

The diagnostic importance of making the distinction between malacia and porosis is stressed. Generalized decreased bone density with a coarsened fibrous effect and an indistinct fuzzy appearance of the cortices constitutes the essence of the roentgen manifestations of the malacic group. Generalized decreased bone density with thin, sharply defined trabecular pattern giving a pencilling effect or, in fine textured bone, a ground-glass appearance is characteristic of the porotic group. Simply stated, in malacia the bones are soft and coarse, while in porosis they are brittle and homogeneous.—*Harold C. Hamilton, M.D.*

Gedda, Luigi, and Iannaccone, Guido. Il torcicollo osseo congenito nel quadro della *Schisosinostosi Assiale Congenita Familiare.* (Congenital osseous torticollis in schisosynostosis axialis congenita familiaris.) *Acta genet. med. et gemellologiae*, Jan., 1957, *6*, 1–23. (From: Istituto di Genetica Medica e Gemellologia and Istituto di Radiologia Medica dell'Università, Rome, Italy.)

In a previous article on "Klippel-Feil syndrome" the authors stated that in many cases it can be attributed to a hereditary disease of the axial skeleton. The expression of this disease may be grossly evident or may show very little or no outward manifestations. The latter group is characterized by failure of osseous structures to fuse or by synostoses. The authors recommend that it be identified as "schisosynostosis axialis congenita familiaris."

Their present report deals with a twin suffering from congenital osseous torticollis. The co-twin who outwardly appeared to be healthy and normal was found to have posterior synostosis of C2 and C3 vertebrae and spina bifida occulta of S1 and S2 as well as sacralization of L5 and a slight degree of platyspondyly.

The father of these twins was found to have basal segmentation of the odontoid process, cervical kyphosis and spina bifida occulta of S1. A brother of this father was examined and found to have synostosis of the laminae of C2 and C3.

In their discussion the authors conclude that congenital osseous torticollis can be ascribed to "schisosynostosis axialis congenita familiaris" and represents another possible anatomo-clinical expression of the Klippel-Feil syndrome.—*Peter E. Russo, M.D.*

Clément, Robert, Combes-Hamelle, A., Richir, C., Designolle, M., Poujol, J., and Flieder, J. (Paris, France.) Ostéopétrose généralisée du nourrisson (maladie d'Albers-Schönberg) avec adénomégalies de type hodgkinien. (Generalized osteopetrosis of the newborn (Albers-Schönberg's disease) with adenopathy of Hodgkin's type.) *Presse méd.*, March 20, 1957, *65*, 513–516.

This is a case report of osteopetrosis or marble bones (Albers-Schönberg's disease) which was discovered soon after birth and observed the following nine months, until death of the infant.

In the long and short bones, as well as in the skull, there was osseous condensation proceeding from the center toward the periphery. In the iliac and scapular bones the central portions were dense and the peripheral portions relatively radiolucent. In the skull the basal bones, especially the sphenoid, showed greater density. At the age of eight months, two incisor teeth appeared which were radiolucent centrally and dense in the enamel layer.

The liver and lymph nodes of several regions were enlarged and histologically showed reticular hyperplasia and hyalinized vessels, somewhat resembling Hodgkin's disease. The very large spleen showed only reticular hyperplasia and did not resemble Hodgkin's disease.

Two similar cases are cited from the literature, thus indicating that this disease may be a disorder of primitive mesenchymal substrate.—*Charles M. Nice, Jr., M.D.*

Blood and Lymph System

Babaiantz, L., Rivier, J.-L., Desbaillets, P., and Candardjis, G. L'angiocardiographie. (Angiocardiography.) *Radiol. clin.*, Sept., 1956, *25*, 321–346. (From: Institut universitaire de radiologie et Clinique médicale universitaire, Lausanne, Switzerland.)

Although angiocardiography had been used in Switzerland since 1948, this is the first comprehensive report regarding the topic presented at a major Swiss radiological meeting. The availability of contrast media of lesser toxicity, and improvements in serial roentgenographic techniques have contributed to develop angiocardiography, paralleling the progress of cardiac catheterization. The aim of angiocardiography is the morphologic and topographic exploration of endothoracic vessels, of cardiac chambers, and of the myocardium, being also of help in hemodynamic studies. In addition, it has been used successfully to

differentiate between mediastinal tumors and aortic aneurysm, and between bronchopulmonary neoplasms and arteriovenous aneurysm. It is also an excellent method for the demonstration of pulmonary vascularization in pneumoconiosis, neoplasms, etc.

The method requires team work, preferably including specialists for all the aspects involved. The two fundamental techniques, the global (intravenous) and the selective (through cardiac catheterism), complement each other; incidentally, neither is believed to be physiologic.

Regarding the indication for angiocardiography, the authors have established several categories: (1) cardiopathies in which the method is justified and often indispensable, including the tetralogy of Fallot, pure pulmonary stenosis, anomalies of the aortic arch and its branches (for instance, coarctation), aortic orificial stenosis, pulmonary arteriovenous aneurysm, thrombosis of either auricular appendage, and heart tumors; (2) cardiopathies in which angiocardiography is only relatively indicated, for instance, Eisenmenger complex, Ebstein's disease tricuspid atresia with interatrial defect, cor bi- and triloculare, truncus arteriosus, partial or total transposition, with or without septal defect, anomalies of the superior vena cava, dextrocardy or levocardy without situs inversus; (3) cardiopathies in which the indication for angiocardiography is doubtful are Roger's malady, interatrial communication, persistent ductus arteriosus, and Lutembacher's disease; and (4) the contraindications of angiocardiography are *absolute* (iodine intolerance, renal insufficiency, recent mercurial treatment, very narrow pure aortic or pulmonary stenosis, cardiopathies which infringe selectively and intensively upon the lesser circulation, and pregnancy as well as the menstrual period) and *relative* (pulmonary arterial hypertension, systemic arterial hypertension, considerable volumetric increase of the heart chambers, conductivity disturbances, and minimal cardiac insufficiency, but with pulmonary involvement).

Eight illustrative cases are briefly discussed.—*E. R. N. Grigg, M.D.*

Culver, Gordon J., and Pirson, Herbert S. Splenic artery aneurysms; report of 17 cases showing calcification on plain roentgenograms. *Radiology*, Feb., 1957, *68*, 217–223. (Address: G. J. Culver, Buffalo General Hospital, Buffalo, N. Y.)

The authors review the literature on splenic artery aneurysm and discuss its clinical picture and roentgenographic appearance. Reports of 6 proved cases, showing ring-like calcification on roentgenograms, are presented.

The diagnosis of splenic artery aneurysm can be made roentgenographically when calcium is present in its walls. This appears as an oval or round radiopaque density in the left upper quadrant of the abdomen. Sometimes calcium can be seen in the splenic artery extending to the aneurysm. Other causes of calcification in this region which must be considered in differential diagnosis are: calcified aneurysm of the left renal artery, calcified echinococcus cyst, calcified splenic cyst, renal cortex calcification, calcified blood clot, enteroliths and calcification in neoplasms.

All of the cases in this series were females, ranging in age from forty-nine to seventy-nine years. Four had single aneurysms. The average diameter of the aneurysm was 2.2 cm. Pain in the epigastrium or left upper quadrant of the abdomen was the most common complaint.—*Arno W. Sommer, M.D.*

Bergstrand, I., and Ekman, C.-A. Portal circulation in portal hypertension. *Acta radiol.*, Jan., 1957, *47*, 1–22. (From: Roentgendiagnostic Department and Surgical Department, University Hospital, Lund, Sweden.)

Lienoportal venography has proved useful in evaluation of circulatory disturbances in portal obstruction. An investigation based on 115 lienoportal venographies was carried out and changes in collateral circulation, velocity of flow, and width of portal and splenic veins as seen in subjects with and without portal hypertension were studied.

In 90 of the 115 examinations the spleen was punctured, while the patient was holding a deep breath. In the remaining 25, puncture was performed with the patient in the resting respiratory state, and this latter method is now used routinely.

A filling of branches from the splenic vein and/or portal vein was taken as a sign of collateral circulation. Filling of small vessels from the hilus of spleen was, however, not considered pathologic.

Assessment of velocity of portal flow was carried out in 4 ways. In 63 examinations, an automatic film changer was used and the velocity was judged as follows: (1) Measurement of the distance that the head of the contrast medium had advanced between 2 consecutive exposures (velocity in cm./sec); (2) measurement of the interval between the beginning of the injection of contrast medium until demonstration of bifurcation of the portal trunk in the liver hilus (spleen hilus time); (3) measurement of the interval between injection and the moment the contrast medium filled the smallest observable intrahepatic portal branches in the right lobe (spleen-liver hilus); and (4) measurement of the interval between the end of the injection and the moment the intrahepatic branches were no longer discernible (emptying time of portal branches).

The widths of the splenic and portal veins were measured at the widest points.

The 115 examinations were done on 88 patients, in 70 of whom diagnoses were confirmed at laparotomy. Fifteen were controls. Eighteen patients had expansive processes, 38 had cirrhosis, 9 had extrahepatic thrombosis, and 8 had miscellaneous diseases.

In assessing the value of the method in the diagnosis of portal hypertension, the diagnosis was made on the basis of typical signs and symptoms: Bleeding from upper alimentary tract, splenomegaly, and, in some cases, ascites. With but 1 exception, all patients with collaterals were examined roentgenologically for varices. Of 48 such cases, varices were demonstrated roentgenologically in 43 and in 2 additional cases, more varices were demonstrated in the stomach. In none of the patients without collaterals did the roentgen examination reveal varices.

A filling of collaterals was regularly obtained in the presence of portal hypertension but never in its absence.

The velocity of flow in the portal circulation was practically always lower in the presence of portal hypertension.

The widths of splenic and portal veins were often increased in the presence of portal hypertension.

In cirrhosis the accumulation of contrast medium in the liver parenchyma was less dense and the hepatic veins were less frequently demonstrated than in controls.

The method used in this investigation was judged accurate enough for clinical diagnosis of portal hypertension.—*Lois Cowan Collins, M.D.*

Lester, Jack, and Lampe, Carl E. Intra-osseous venography with special reference to its complications. *Brit. J. Radiol.*, March, 1957, *30*, 145–147. (From: Department of Radiology, Copenhagen County Hospital, Gentofte, Denmark.)

In venography of the lower limbs, it sometimes is difficult to find suitable veins for percutaneous injection, and it may also be difficult to force the contrast medium into the deep veins by injection into the superficial ones. As it has appeared that following intra-osseous injection, the contrast medium rapidly runs centrally through the deep veins, several authors have recommended the latter method during recent years. The authors have had a higher frequency of complications than have been reported in the literature and, therefore, deemed it advisable to publish their experience.

They have performed intra-osseous venography on 13 patients, in 1 case on both sides. There were 6 females and 7 males, their ages ranging from twenty-four to fifty-three, the average being forty-two years. All patients had varicose veins and most of them had previously had phlebitis with complications. All were closely followed as regards complications and were subjected to repeated examinations, including roentgenograms of the site of injection. Complications consisted mostly of local reactions. Considerable subcutaneous leakage of contrast medium was found in only one case due to faulty technique. All patients complained of pain after the injection. In about half, the pain was mild and of short duration (less than one week), the remaining had more intense pain, which in 2 cases persisted for a month. An elevation of temperature occurred in 4 patients. Thrombophlebitis developed in 2 instances. Delayed hemorrhage occurred in 1 case where there were no other complications.

The observations were carried out for periods of from three to thirteen months. The 2 patients with thrombophlebitis still revealed slight tenderness at the site of injection six months after venography. The others had no sequelae which could be attributed to the venography.

The authors conclude that the method is indicated only in special cases, since complications are apt to occur. Its use is recommended when the following requirements are fulfilled: (1) percutaneous injection is impossible owing to the absence of suitable veins; (2) examination is performed by an experienced administrator; (3) the concentration of the contrast medium does not exceed 35 per cent; and (4) the injection needle is held firmly in place by the cortex throughout the injection.—*Robert D. Moreton, M.D.*

Steinberg, Israel, and Ryan, Bernard K. Corner positioning for visualization of the brachiocephalic vessels. *Radiology*, Feb., 1957, *68*, 242–244. (Address: I. Steinberg, 525 E. 68th St., New York 21, N. Y.)

In order to better demonstrate the brachiocephalic vessels (*i.e.*, the branches of the innominate vein, and the innominate, left common carotid and left subclavian arteries) during angiocardiography, the authors suggest the use of corner positioning. This technique is not new, having long been employed in roentgenography of the extremities and skull. It makes use of the principle that the diagonal of a square is greater than any of the sides. Placing the head of the patient in a corner of a 12×12 inch roll-film magazine provides a field 17 inches in length, a space more than ample for the head and shoulders even of the adult. Serial angiocardiograms, with the patient in this position, provide multiple views of the brachiocephalic veins and arteries.

The veins from the head and neck join the upper extremity veins to form the innominate veins in an inverted "T" figure. Similarly, the brachiocephalic arteries emerge from the aortic arch and proceed to the arms and neck in an inverted "T" fashion. The arrangement of these vessels is such that corner positioning of the head is ideal for their demonstration. With the arms at the side, even the brachial arteries can be seen. As a result, significant information regarding these vessels can be obtained.—*A. R. Watson, M.D.*

Servelle, M., Albeaux-Fernet, M., Laborde, S., Chabot, J., and Rougeulle, J. (Paris, France.) Lésions des vaisseaux lymphatiques dans les malformations congénitales

des veines profondes. (Lesions of the lymphatic vessels in congenital malformations of the deep veins.) *Presse méd.*, March 20, 1957, *65*, 531–534.

Since 1943 the authors have studied 80 patients with syndrome of Klippel and Trenaunay. This affectation is characterized clinically by edema of an extremity with osseous enlargement of the same limb, varices and perhaps a flat angioma. Compression of the popliteal vein was found in 80 per cent, and of the femoral vein in 20 per cent. In one case there was an agenesis of the popliteal vein. Experimentally, osseous enlargement has been produced by venous ligation.

When a fibrovascular malformation compresses the vessels of an extremity, it affects not only the venous circulation but also the deep lymphatic pathways. This explains the edema of the extremities in this condition.

There may be lymphatic malformations coexisting in other parts of the body as in one patient eight years of age who sustained a rupture of a malformed thoracic duct with ensuing chylothorax.

Sometimes the lymphatics become so enlarged that contrast agents may be injected to demonstrate the dilated, tortuous lymphatics roentgenographically. Stasis may be so severe that the contrast material is still demonstrated twenty minutes after injection.

The lymphatic changes are not observed in congenital arteriovenous malformations of the extremities.—*Charles M. Nice, Jr., M.D.*

Kaye, Josse, Sarif, S. J., and Denny, M. B. M. Aortography with simultaneous bilateral arteriography of the lower extremities. *Brit. J. Radiol.*, Jan., 1957, *30*, 13–18. (From: Department of Radiology, Johannesburg General Hospital, and Vascular Disease Clinic of the University of the Witwatersrand, Witwatersrand, South Africa.)

The paper proposes to clarify the pathologic and technical considerations involved in arteriography of the lower extremities. Because the disease process may involve the pelvic vessels, the femoral artery in the region of Hunter's canal and, frequently, the other limb, the authors recommend simultaneous bilateral arteriography including the pelvic vessels. Furthermore, in order to account for variations in the rate of flow, serial arteriograms are of value.

Using 40 to 60 cc. of urografin, 76 per cent, the authors detail a procedure with the retrograde Seldinger technique whereby serial overlapping roentgenograms are taken of the pelvis and both legs. The apparatus and sequence of events are well detailed with proposed modifications noted.—*William C. MacCarty, Jr., M.D.*

General

Nixon, W. C. Improved definition in x-ray diagnosis by high voltage projection microradiography. *Brit. J. Radiol.*, Dec., 1957, *29*, 657–662. (From: Cavendish Laboratory, Cambridge University, Cambridge, Mass.)

The author describes a special type of roentgen-ray tube with a point source of electrons striking a thin window anode or target in the end of the tube. Using a 10 μ roentgen-ray source at 50 kv. and 10 cm. film distance, they have produced roentgenograms of bones which show sharp resolution, when enlarged 10 times by direct roentgen-ray projection. The author believes that this system offers considerable promise for medical roentgenography, especially since the roentgen-ray image intensifiers now available will make up for the loss of intensity and still preserve the high definition.

This is a highly technical preliminary report which should be read in the original by those interested.—*J. L. Williams, M.D.*

Steinbach, Howard L., and Johnstone, Herbert G. The roentgen diagnosis of Armillifer infection (porocephalosis) in man. *Radiology*, Feb., 1957, *68*, 234–237. (Address: H. L. Steinbach, University of California Medical Center, San Francisco 22, Calif.)

A case of human infection with Armillifer moniliformis, the third instance of parasitism in man by these degenerate worm-like arthropods to be reported in the United States, is described. The adult form of this species is parasitic in snakes in India, Malaya, and the East Indies. Infection of man is through ingestion of the eggs of the adult parasite which have been passed in the bronchial secretions or the excreta of snakes. The larvae are liberated from the egg in the intestine and penetrate to the liver, lungs, mesenteric lymph nodes, kidneys, and other organs. During development, the larva molts several times and is finally encysted as a nymph. The demonstration of the nymphs on roentgenograms depends upon their death and calcification.

The roentgen appearance of the calcified nymphs is pathognomonic and is the only practical means of establishing the diagnosis, short of laparotomy and biopsy. The calcific shadow is from 3 to 6 mm. in length and varies in shape from semilunar to rectilinear, depending upon the plane in which the nymph lies. Rectilinear shadows cannot be differentiated from those due to Cysticercus cellulosae, but if semilunar shapes are present among the usually numerous calcified lesions, the diagnosis can be made. The lesions have been seen only within the thoracic and peritoneal cavities, with the exception of the present case, in which calcified nymphs were present also within the scrotum. In most reported

cases the infection was thought to be of no clinical significance.—*Harold C. Hamilton, M.D.*

RADIATION THERAPY

Chu, Florence C. H. The results of treatment of ovarian cancer with one million volt x-ray. *Surg., Gynec. & Obst.*, Jan., 1957, *104*, 45–52. (From: Department of Radiation Therapy, Memorial Center for Cancer and Allied Diseases, New York, N. Y.)

Between 1949 and 1953, 112 patients with ovarian malignancy were treated with one million volt roentgen rays at the Memorial Center for Cancer and Allied Diseases, New York. Most of these (90) were patients who had recurrent or incomplete excision of their tumors.

The basic plan was to treat opposing 30×30 cm. abdominal or pelvic ports to give a tumor dose of 4,000 r in four to five weeks. Most patients received between 3,000 to 4,000 r.

In the adenocarcinomas receiving radiation alone, there was a failure of objective and subjective response in 31 per cent (17 patients), half of whom received less than 3,000 r tumor dose. Of the 69 per cent (35 patients) with a favorable response, almost all (31) received over 3,000 r. The author thus considers 3,000 r tumor dose as a critical minimum for this lesion.

Of the 3 types of serous adenocarcinoma (papillary, solid, mixed) there was little difference in response to radiation.

The author concludes that though most ovarian carcinomas are radioresistant, irradiation (particularly with one million volt roentgen rays) has value in their management.—*Henry J. Klos, M.D.*

Clayton, Ralph S., Sr. Carcinoma of the cervix uteri: Ten-year study with comparison of results of irradiation and radical surgery. *Radiology*, Jan., 1957, *68*, 74–79. (Address: 1501 Arizona St., El Paso, Texas.)

The author presents the results of a study of 231 cases of invasive carcinoma of the uterine cervix seen during a ten year period. Two hundred patients received radiation therapy (6 received both surgical and radiation therapy), 31 were treated surgically.

The clinical stages of the 191 cases who received their initial treatment at Parkland Hospital were as follows: Stage I, 24 cases; Stage II, 29; Stage III, 75; Stage IV, 63.

Various combinations of external and transvaginal roentgen irradiation and intracavitary and interstitial radium were employed. There were no deaths attributable to irradiation. In 163 patients, or 81.5 per cent, there was no significant morbidity. Five year survival for the 110 patients treated initially by irradiation during the first five years of the study was as follows: Stage I, 81.2 per cent; Stage II, 40 per cent; Stage III, 18.6 per cent; and Stage IV, 5.4 per cent.

Thirty-five patients were treated by radical hysterectomy and pelvic lymphadenectomy. Two underwent pelvic exenteration for cancer recurrent after initial irradiation. The operative mortality for the entire group was 13.5 per cent. The combined death and major morbidity incidence in the hysterectomy and pelvic lymphadenectomy group was 45.7 per cent. Five year survival could not be determined in this group since the operations were performed during the years 1946–1953 inclusive. No evidence of cancer was found in the operative specimens from 13 (37 per cent) of the patients undergoing hysterectomy and pelvic lymphadenectomy.

It is concluded that operation is not indicated as the primary treatment of invasive carcinoma of the cervix. A plan is suggested combining the advantages of both therapeutic procedures. This would involve surgical removal of the uterus and adenexa, and uniform irradiation of the entire potential cancer-bearing areas of the pelvic floor and walls by mold technique while protecting the rectum and bladder with appropriate shields, and displacing the intestine out of the pelvis during the treatment period.—*A. W. Sommer, M.D.*

Nitter, Lorentz. The treatment of malignant melanoma with special reference to the possible effect of radiotherapy. *Acta radiol.*, Sept., 1956, *46*, 547–562. (From: The General Department, Norwegian Radium Hospital, Oslo, Norway.)

It is commonly assumed that melanomas of the skin are radioresistant and radiation therapy is often ignored in the management of this neoplasm. Efforts are more often concentrated on more radical surgery.

Surgical results (Pack) for treatment of melanoma are about 27 per cent over-all five year survival (40 per cent if no regional lymph node and 14 per cent if regional lymph node involvement is present). Results for radiation therapy without surgical interference are not available for proved cases. The author reports a series of 192 cases which were treated at least five years before this paper, but treated frequently by conservative surgery along with radiation therapy. The author attempts to evaluate the effect of the radiation therapy.

The plan of treatment was surgical excision of the lesion and possibly the regional lymph nodes, followed by radium mold or teleradium to the scar. In some cases, roentgen therapy was given to the regional lymph nodes (3,500 r skin dose at 175 kv., 1 mm. copper filter, 50 cm. target skin distance).

The over-all five year survival for 167 patients with melanomas of the skin was 26 per cent. Further evaluation was difficult because of the mixture of

modalities used. The author reports a five year survival of 37.5 per cent for melanomas limited to the skin (without lymph node involvement) for the most frequent combination of excision and radium mold application. This is increased to almost 50 per cent by prophylactic irradiation of the regional lymph nodes (number of cases so treated is admittedly small).

These results compare favorably with radical surgical results, indicating some effect of radiation.—*Henry J. Klos, M.D.*

Dohan, F. C., Raventos, A., Boucot, N., and Rose, E. Roentgen therapy in Cushing's syndrome without adrenocortical tumor. *J. Clin. Endocrinol. & Metabol.*, Jan., 1957, *17*, 8–32. (From: Department of Medicine, School of Medicine, University of Pennsylvania, and the Endocrine Section of the Medical Clinic and the Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia, Pa.)

Between 1932 and 1952, 12 cases of Cushing's syndrome without demonstrable adrenocortical tumor were treated by the authors by irradiation of the pituitary gland. Five of these demonstrated an excellent response.

Those patients receiving the higher tissue doses (mean 4,350 r; range 3,800–5,250 r) showed the good responses. Those receiving the lower tissue doses (mean 1,339 r; range 400 to 4550) showed the poor responses. Repeat courses of therapy did not improve results. The technique involved the use of multiple ports.

By reviewing their own 12 cases and 24 suitable cases in the literature, the authors believe they can show that the daily tissue dose is more important than the total dose to the pituitary (or, perhaps, hypothalamus). The tissue doses of the evaluated cases were plotted against the number of days over which the therapy was given. Those with favorable responses fell for the most part to one side of a line which would indicate that 440 r total tissue dose at a rate of 110 r per day (tissue dose) for four days is as effective as 4,000 r tissue dose in forty days.

In the authors' cases one patient developed what might have been a pituitary deficiency after therapy, with weight loss, weakness and anorexia, but this was temporary.

Detectable response to radiation occurred in three months in the successful cases, but six months were required for marked improvement.—*Henry J. Klos, M.D.*

Seaman, William B., and Eagleton, Mark D. Radiation therapy of neuroblastoma. *Radiology*, Jan., 1957, *68*, 1–8. (Address: W. B. Seaman, Presbyterian Hospital, 630 W. 168th St., New York 32, N. Y.)

The prognosis of children with neuroblastoma has shown remarkable improvement in recent years. This is thought to be due to the possible influence on the processes of maturation and spontaneous regression by a variety of agents, including roentgen therapy, nitrogen mustard, cortisone, antifolics, and surgical trauma (biopsy or partial removal).

The authors discuss their experience with 19 patients, with a histologically proved diagnosis of neuroblastoma, seen at the Mallinckrodt Institute of Radiology. Five of these patients survived from forty-five to seventy-six months, a three-year survival patient had histologically verified osseous metastases and another had microscopic evidence of liver metastases.

Since most neuroblastomas are radiosensitive, aggressive therapy is justified, regardless of the extent of its dissemination. Although cures have been obtained with as small a tumor dose as 400 r in sixteen days, the authors feel that tumor doses varying from 1,300 r to 3,000 r in twenty-two to fifty-five days are better. Treatment should be individualized according to the response of the tumor and the general condition of the patient. If marked leukopenia and debilitation develop, therapy should be temporarily discontinued.

Late sequelae due to radiation damage may be expected in these children as the survival times increase but this is unavoidable if clinical cure is the goal. Scoliosis will frequently occur, but may be minimized if the entire width of the vertebral bodies is included in the field of irradiation. Lumbar lordosis may occur due chiefly to fibrosis and atrophy of the lumbar erector spinae muscles.

In this and other reported series it seems that higher survival rates occurred more frequently in the younger age groups. These findings suggest that the younger the child when therapy is given, the better the prognosis.

In conclusion the authors state that the presence of extensive disease with metastases should not be a contraindication for radiation therapy because of the occasional survivals.—*Donald N. Dysart, M.D.*

Zuppinger, A., and Renfer, H. R. Die Röntgenvorbestrahlung. (Preliminary roentgen irradiation.) *Radiol. clin.*, Nov., 1956, *25*, 384–408. (From: Röntgeninstitut der Universität und des Inselspitals, Bern, Switzerland.)

Despite occasional successes, the treatment of malignant tumors is still in need of substantial improvement. Among the methods which could contribute to this aim, the authors have selected *preoperative roentgen irradiation*, which they strongly advocate. Its *advantages* are said to be the possibility to shrink an inoperable tumor down to surgical size, to reduce an operable tumor to the point where a lesser intervention becomes feasible (the procedure is actually recommended in routine cases), and to minimize the hazard of mechanical dislodgement of

tumor fragments during surgery, which should then reduce the incidence of local recurrences as well as of distant metastases. Among the *disadvantages* is an occasional delay in wound healing, and the prolongation of the total treatment time; it is mentioned that these delays may at times exceed the patience of the most cooperative surgeon.

The main discussion concerns the treatment of carcinoma of the breast, and includes the statement that in Stages I and especially II, preoperative roentgen irradiation has a better record than any other procedure. When only preoperative irradiation is planned, the tumor dose may be raised to 3,500–4,500 r in three to four weeks, the dose to the lymph nodes to about 3,000 r. When pre- and postoperative irradiation is considered, 2–3,000 r in two to three weeks to the tumor, and 2,000 to the lumph nodes may be given before the intervention. At any rate, moist skin reaction must be avoided over the "surgical" (axillary as well as local) skin portions. After a positive biopsy, mastectomy should be performed at once, adding irradiation later. The authors believe that one is justified to give 2,000 r before the biopsy, then, if necessary, amputate, and complete the irradiation.

It is contended that preoperative roentgen irradiation has definitely improved the over-all results in the treatment of Wilms' tumor (3,000–5,000 r before, while level of postoperative dose, if any, will depend on circumstances), of maxillary tumor (two thirds of the total dose of 7,000 r before surgery, the remainder afterwards), and of carcinoma of the rectum (5,000–6,000 r), especially to impart surgical possibilities to a previously inoperable situation.

The method is also offered for other locations, although the authors have not attempted it in bronchogenic carcinoma, especially because of early metastases and local extension. Briefly discussed are statistics of 21 gastric malignancies, treated with the betatron. After excluding postoperative recurrences and cases with known metastases, there remained 9 patients of questionable operability at the time of irradiation. Some received as much as 11,000 r in up to seventy days, but the dose recommended is 7,000 r (corresponding to about 5,000 r of conventional roentgen rays). Of these 9 patients, 4 died within four to eighteen months (3 with liver metastates, one after radical operation), while 5 are alive and asymptomatic four to thirteen months afterwards (2 had also radical surgery, one had less than radical resection with postoperative irradiation, 2 were not operated on because tumor could not be demonstrated after irradiation).—*E. R. N. Grigg, M.D.*

Haas, Lewis L., Harvey, Roger A., and Melchor, Charles F. Radiation management of apical lung tumors. *J. Thoracic Surg.*, April, 1957, *33*, 496–525. (From: Department of Radiology, College of Medicine, University of Illinois, Chicago, Ill.)

This is a study of the effect of radiation, conventional roentgen rays and betatron roentgen rays, on apical lung tumors. While apical lung tumors do not form a separate pathologic entity, their peripheral location predisposes them to different clinical behavior from other lung tumors. The authors define "apical" lung tumors as tumors arising in the peripheral portion of the lung apex, not the anatomic apical segment. These lesions show an early tendency to peripheral invasion of the extrapulmonary tissues with the clinical manifestation of pleural thickening, Horner's syndrome, shoulder-arm pains, and rib destruction.

Eighteen cases were irradiated: 8 received conventional roentgen therapy and 10 received 22.3 mev. betatron roentgen therapy. All of the patients had extrapulmonary invasion at the time of the treatment. In the 8 cases treated with conventional roentgen therapy the estimated tumor dose varied between 4,200 and 7,500 r in 30 to 129 days. The quality of the roentgen rays varied from a half-value layer of 0.9 mm. Cu (200 kv.) to a half-value layer of 2.75 mm. Cu (400 kv.). The tumor dose in the 10 patients treated with the 22.3 mev. roentgen rays varied from 8,000 to 11,500 betatron r in 26 to 44 days. Five fields were usually used and they measured up to 15 cm. in diameter.

Survival, after treatment, in 7 patients treated with conventional roentgen therapy, ranged from three to nine months. The eighth patient is living and well after eleven years. The average survival, after treatment, in the first noted 7 patients averaged six months. Survival time averaged seven and one-half months if patients with distant metastases, at the time of treatment, are excluded.

Of the 10 cases given betatron roentgen therapy, 2 are living and well eleven and twenty-seven months after irradiation. The other 8 patients, now deceased, survived three to forty-eight months after irradiation with an average survival of 19.6 months. Survival time averaged 32.4 months, against 7.5 months with conventional roentgen therapy, if patients with distant or regional metastases are excluded.

Significant palliation as judged by subsidence of chest, shoulder, arm and hand pain as well as cough, hemoptysis, and dyspnea was accomplished in 2 of the 7 deceased patients treated with conventional roentgen therapy and in 7 of the 8 patients treated with betatron roentgen therapy.

No clinically significant untoward skin or lung reactions were observed. Of the 2 cases suspected of having radiation myelitis, one was proved to have neoplastic spinal involvement and the second also probably had the latter.—*Paul C. Olfelt, M.D.*

Murphy, Walter T. Primary vaginal cancer: Irradiation management and end-results. *Radiology*, Feb., 1957, *68*, 157–168. (Roswell Park Memorial Institute, Buffalo 3, N. Y.)

The fact that primary vaginal cancer can be cured by irradiation in a relatively high percentage of cases is substantiated by this report of 135 cases treated at the Roswell Park Memorial Institute between 1919 and 1949. In this series of cases, the following methods of treatment were used, either alone or in combination: radium surface applicators, implantation of radium needles or radon seeds, transvaginal roentgen irradiation, and external roentgen therapy. The techniques used are described.

Clinically, the cases were classified in the following groups: Stage I: The lesion is limited to the vagina or the immediate paravaginal tissue. It may secondarily involve the face of the cervix, but not the mucosquamous junction. Stage II: The lesion (a) has extended beyond the immediate paravaginal tissue, (b) has invaded the urethra, bladder, rectum, or vulva, or (c) has metastasized to the regional lymph nodes or outside of the pelvis, etc. Stage III: The lesion has had definitive treatment before admission to the Institute.

The absolute five year cure rate of the patients who received their complete treatment at the Roswell Park Memorial Institute was 24.2 per cent. Patients in the Stage I group showed a 31.6 per cent and Stage II an 11.1 per cent five year cure rate. Since many patients were treated during years when radiation therapy was very inadequate, it was thought that a review of the cases treated after 1940 would be of interest. This study revealed a 69.2 per cent cure in Stage I lesions and a 23 per cent cure in Stage II lesions. Therefore, it can be seen that the absolute five-year cure for this group was 46.2 per cent in comparison with 24.2 per cent for the entire comparable group.

The author concludes that if vaginal cancer is discovered before it has extended beyond the vagina proper, the radiation treatment end-result is good. Even though the cancer has extended beyond the vagina itself, intensive irradiation will salvage a few cases. Results show that roentgen therapy plays a very important part in the radiologic management of primary vaginal cancer.—*A. R. Watson, M.D.*

MAISIN, J., MAISIN, H., DUNJIC, A., and MALDAGUE, P. Des divers mécanismes de mort après irradiation totale et subtotale. (Various mechanisms of death after total and subtotal irradiations.) *J. belge de radiol.*, 1957, *40*, 75–106. (From: Laboratoires de Recherches pour la Protection de la Population Civile annexés au Département de Radiobiologie de l'Institut du Cancer de l'Université Catholique de Louvain, Louvain, Belgium.)

In laboratory animals, the level of single, total body roentgen irradiation determines both the survival time, and the manner of death. Massive doses cause instantaneous, molecular death (Rajevsky), 12,000 r and over result in immediate, nervous death (Henshaw), between 1,000 and 12,000 r, death supervenes after 3½–7 days of gastrointestinal disturbances (Quastler), with 500 r, there occurs medullary aplasia with death in 8–20 days (Heinecke, Lacassagne), while sublethal doses shorten the average lifespan, due to tardive death by various subacute pathologic states, or by cancer.

In the present study, four months old, white, homozygotic rats, weighing 145–165 gm., were irradiated with a Maxitron 250 kv. which at 60 cm. (filter ¼ mm. Cu and 1 mm. Al) has an output of 90 r/min. In this series, 600 r caused 50 per cent mortality in thirty days, 850 r 100 per cent in sixteen days, and 1,000 r 100 per cent in eight days. The modifications included partial *mechanical protection* by lead shields covering certain parts of the body, *chemical protection*, by injecting 10 mg. of MEA (mercaptolethylamine) per rat prior of irradiation, *biologic protection*, by injecting after the irradiation about 60 mg. of fresh, homologous bone marrow, and a combination of two of above methods. Appropriate shileding was employed to establish the dosages needed to induce various syndromes, for instance at least 400 r are required over the entire body to give myeloid aplasia, at least 700 r (total body or only over the abdomen) for the intestinal syndrome, at least 1,000 r over the thorax for the pulmonary syndrome, at least 1,250 r over the head for the oropharyngeal syndrome, and at least 2,250 r over the thorax for the esophageal syndrome.

When protected by MEA, it seems as if the radiosensitivity of that particular organ, or group of organs, were raised. The LD_{100}, which is 800 r in the case of a medullary syndrome, increases to 1,000 r after administration of MEA; the figures are 1,000 r (without) and 1,500 r (with MEA) for the gastrointestinal syndrome; 1,750 r (without) and 2,500 r (with MEA) for the oropharyngeal syndrome; and 3,500 r (without) and 4,500 r (with MEA) for the esophageal syndrome. MEA has little, if any, effect on the pulmonary syndrome, for which the LD_{100} is 1,500 r, while with MEA it is only slightly above 1,500 r. In the rat, the safety margin between the therapeutic and the toxic dose of MEA is very slim, so that 5 to 20 per cent of the animals were actually killed by poisoning with MEA. And yet, there seems to be experimental evidence that MEA could be of value in protecting the skin, for instance when skin tolerance is stretched to deliver a sufficient depth dose.

Intraperitoneal or intravenous injections of normal saline suspensions of rat embryo, of liver from rat embryo, or of fresh bone marrow, result in (likewise partial) biologic protection against the medullary syndrome. Tagging with radioactive Fe^{59} showed that in the case of homologous bone marrow, the introduced red cells are utilized at once, which is not possible with heterologous bone marrow.

To estimate shortening of the average lifespan, and the carcinogenic effect of whole body irradiation,

the authors analyze data for 1,264 rats, which survived six months or longer after total or modified (subtotal) body irradiation; 928 died after the sixth month (336 survivors), and there were 60 cancers and 4 other tumors. Of 481 rats which survived ten months, 239 succumbed after the tenth month (242 survivors), and there were 9 cancers; 80.3 per cent of the neoplasms appeared in the abdomen, and only 19.7 per cent (7 epiteliomas and 3 sarcomas) in other parts of the body. Shielding of the abdomen during whole body irradiation in the rat reduces the over-all incidence of postirradiation cancer. This would seem to speak in favor of the theory that the carcinogenic effect of roentgen rays is exerted by direct action upon susceptible cells or organs. However, it does not exclude the possibility that there exists (also an indirect cancerization mechanism, which could be blocked by an humoral factor.—*E. R. N. Grigg, M.D.*

RADIOISOTOPES

Roche, Marcel; de Venanzi, Francisco; Vera, Jorge; Coll, Eduardo; Spinetti-Berti, Mario; Mendez-Martinez, José; Gerardi, Andrés; and Forero, José. Endemic goiter in Venezuela studied with I^{131}. *J. Clin. Endocrinol. & Metabol.*, Jan., 1957, *17*, 99–110. (From: Instituto de Investigaciones Médicas, Fundación Luis Roche, Plaza Morelos, Caracas, Venezuela.)

In an area in western Venezuela noted for endemic goiter, 1,359 subjects were examined for thyroid disorders. The group was evenly divided as to sex and approximately one-half were children.

With no statistical differences among the grouping, 83 per cent of the total had clinical goiter. I^{131} uptake studies in 86 goiterous and 24 nongoiterous adults revealed no significant difference in this thyroid function with an average value of 68 per cent. The same was true in 24 children whose uptake averaged 79 per cent.

Fifty-four per cent of adult goiters were nodular. Fifteen of these were studied individually and the lymph nodes of 12 yielded counts below that for nonnodular tissue.

Twelve individuals were given 300–500 mg. potassium perchlorate four hours after the administration of I^{131}, and in 11, a decrease in thyroidal radioactivity occurred promptly.

It is concluded that the principal factor in goiter production in this endemic area is iodine deficiency. The reason for absence of detectable hypertrophy in a certain number of glands with high avidity for iodine is unknown. The examination of nodular glands individually was not of sufficient extent to permit any valid deductions from that portion of the study.—*Dale W. Undem, M.D.*

Sklaroff, David M. Treatment of hemangiomas with the strontium-90 beta-ray applicator. *Radiology*, Jan., 1957, *68*, 87–89. (Address: Albert Einstein Medical Center, York and Tabor Roads, Philadelphia 41, Pa.)

Since beta-rays penetrate only a few millimeters of tissue, many hemangiomas of the "strawberry mark" variety are suitable for treatment with this form of radiation. Strontium-90 is especially useful because of its energetic beta particles, the long half-life, and the absence of gamma rays which simplifies protection. The application is painless, and treatment time is short because of the high output of radiation.

The strontium applicator used by the author contained a 25-millicurie source which delivered 34.6 roentgen equivalent betas per second. Depth dose for the applicator was as follows:

Depth in mm.	Percentage
0	100
1	50
2	25
3	15
4	6
5	2.8

Ten cases of hemangioma were treated by the author with satisfactory results. Only lesions less the 2 mm. in thickness were considered suitable for this form of treatment. The application was made by direct contact to the hemangioma with firm pressure. A dose of 500 rep resulted in disappearance of the lesion and a very good cosmetic result in both of the reported cases.—*A. W. Sommer, M.D.*

Newman, Stanley, and Cupp, Claude M. Influence of iodoalphionic acid (priodax), with and without thyrotropin, on thyroidal I^{131} uptake in euthyroid patients. *J. Clin. Endocrinol. & Metabol.*, Jan., 1957, *17*, 94–98. (From: Isotope Clinic and Department of Medicine, Letterman Army Hospital, San Francisco, Calif.)

The length of depression of thyroidal I^{131} uptake and the effects of thyroid stimulating hormone (T.S.H.) administration after oral priodax were observed in 11 euthyroid individuals.

After ingestion of 3 grams of the cholecystographic medium, I^{131} uptake was reduced to less than 10 per cent during the first week in each case.

Five patients received a total of 11 doses of T.S.H. (5 units I.M.) and in 10 instances, the uptake was elevated to normal within twenty-four hours. This effect was uniformly lost within one week.

Ten subjects were followed until euthyroid with normal levels was reached within thirty days by all

but one. There was no apparent correlation between T.S.H. administration and return to permanently normal I^{131} uptake.—*Dale W. Undem, M.D.*

Oliver, R., and Ellis, Frank. The assessment of thyroid function by measurement of urinary excretion of a radioactive iodine tracer dose—a review of cases examined and consideration of the usefulness of the test. *Brit. J. Radiol.*, March, 1957, *30*, 136–140. (From: Department of Radiotherapy, Churchill Hospital, Oxford, England.)

In accordance with the authors' belief, that "interest now is not . . . in the description of new techniques but in experience (with) the long term clinical use of . . . established methods," results are presented for the procedure which they have used over a period of some seven and one-half years. The method requires the measurement of urine samples over a twenty-four hour period, from which the thyroid rate factor (the fraction of radioactivity removed from the plasma per hour) is found by analysis of the resulting excretion curve. Following an oral dose of 10–25 μc I^{131}, two to three hourly urine samples are collected in disposable cartons and counted individually the following day.

The advantages are that the patient need not be present for counting and the measurement is a purely laboratory procedure free from errors due to gland counting techniques. The possibility of incomplete urine collection is recognized, but with proper preliminary instruction of the patient this is not found to be serious; as all who have experience of this problem know only too well, errors often arise more frequently with in-patients. Also, the excretion curve demonstrates any loss of urine and the necessary correction can generally be applied. Failure of the test for this reason has occurred in only 3 per cent of cases.

Results are analyzed for 517 cases for whom there was initial doubt as to the diagnosis. The clinical evaluation is made by one observer (F. E.), the final diagnosis being after a period of six months or more. All cases requiring no antithyroid treatment are classed as "normal." This tends to obscure the distinction between normal and slight hyperfunction, but is considered to correspond to clinical requirements. The ranges of thyroid rate factors used are: Normal 0.04–0.12; borderline hyperthyroid 0.12–0.20; hyperthyroid 0.20 and above; hypothyroid 0.04 and below.

The final clinical diagnosis for 408 cases is compared with the initial assessment and the thyroid rate factor classification. The remaining 109 cases gave rate factors in the "borderline" region for which it is not possible to differentiate between normal and slightly hyperthyroid, but in 75 per cent of these there was agreement between the initial and final clinical evaluation so that, here, the clinical diagnosis is more useful than the thyroid rate factor which gives better correspondence with the final diagnosis only in the case of normals.

While recognizing the limitations of this type of test, it is considered that it is helpful especially if the diagnosis is complicated by other factors, such as mental disorder or heart failure.—*Raymond S. Quick, B.S.*

Mack, Robert E., Wells, Herschel J., and Pollack, Robert. An in vivo method for the determination of cardiac output. *Radiology*, Feb., 1957, *68*, 245–248. (Address: R. E. Mack, St. Louis VA Hospital, St. Louis, Mo.)

The usual method of determination of cardiac output has been by use of the dye dilution technique. Reports from several centers have indicated similar volume distribution for radioiodinated human serum albumin during the early moments following an intravenous injection. In one method, blood from an intra-arterial needle is led past the sensitive surface of a scintillation counter, making possible a continuous graphic recording of the arterial concentration of the radioactive material.

This paper concerns the study of the use of an external counter positioned over the chest for the determination of the arterial flow curve, the accuracy of the calibration technique required in this method, and the possible clinical application of the procedure. Twenty-two adult men were studied by this technique and 10 had simultaneous studies obtained by serial arterial blood sampling. No significant difference was found between the output values calculated by the 2 methods. The technique is simple and occasions little anxiety in the patient.

The authors conclude that this technique is accurate, reproducible, and readily adaptable to clinical studies. The method of calculation of these values is discussed.—*Donald N. Dysart, M.D.*

Martin, M. Mencer, Walker, Geoffrey, and Chapman, Malcolm. Sodium balance studied with ^{22}Na and an external counter for measuring whole-body radioactivity. *Lancet*, March 30, 1957, *1*, 653–656. (From: Middlesex Hospital, London, England.)

Direct measurements of total body sodium using an external Geiger-Müller counter are compared with a radioisotopic cumulative excretion method and chemical sodium balance data. Results are presented for 6 cases and good agreement is found. The external counter provides a simple, rapid and accurate method for sodium metabolism studies, without the necessity for collection of excreta or measurement of dietary intake, and cumulative errors are avoided.

An oral dose of 25 μc of Na^{22} involves negligible radiation hazard. The reproducibility and accuracy of the method is discussed.—*Raymond S. Quick, B.S.*

Flocks, R. H., Elkins, H. B., and Culp, D. Treatment of cancer of prostate by interstitial injection of Au 198: Studies in problem of distribution. *J. Urol.*, March, 1957, *77*, 505–520. (From: The Department of Urology and Radiology, College of Medicine, State University of Iowa, Iowa City, Iowa.)

The treatment of cancer of the prostate by interstitial injection of Au^{198} is limited to those patients with inoperable cancer without distant metastasis, patients who refuse radical prostatectomy and patients who have some other contraindication to radical prostatectomy for locally operable lesions. The objective of this therapy is not only to destroy the local lesion, but also to destroy neoplasm in the surrounding fascias, in the regional lymph nodes and in the regional lymphatics.

The experience of the authors in 389 patients who have had this therapeutic procedure, indicates that the vast majority of patients have a local lesion which weighs less than 80 mg., so that a total of 80 mc of radioactive gold well-distributed within the prostatic tumor would be quite satisfactory. The problems involved concern the proper distribution of the radioactive gold and maintaining the gold in the prostatic area for a sufficiently long period of time. A satisfactory distribution of the major portion of the administered dose is very difficult to obtain at one sitting. Important factors to be considered for proper distribution of irradiation are: (1) the volume of the injected solution, (2) the use of a spreading factor, (3) the utilization of fascial planes about the prostate, and (4) the technique and the number of injections.

Each one of these factors is discussed in detail. The use of hyaluronidase instead of saline improved the homogeneous distribution of the radioactive material. Studies of injected specimens and in actual patients showed that injected material travels along fascial planes in such a way that it collects around the prostate just inside the capsule. When this is punctured, the material may collect around the rectum and may result in rectal ulceration. Illustrations are given to show the importance of the septa of the prostate and the fascial planes outside the prostate. In the proper distribution of a radioactive substance, it has been found that the use of a highly concentrated radioactive substance in a relatively small volume is most important to prevent rectal complications and extravasation of the contrast medium outside of the prostatic region. The authors prefer to use 3 to 4 cc. of a solution having a concentration of 25–30 millicuries per cubic centimeter. The surgeon should attempt to inject each fascial compartment with a small amount of solution, and the best approach is to combine transvesical and extraprostatic methods. In some patients, where the latter is not possible, the closed perineal or open perineal or transrectal routes may be used. When some areas of carcinoma are not completely destroyed, secondary injections by the retropubic transvesical method or by the perineal method or transurethral resection are employed. Several illustrations point out the value of secondary injections. Where large masses of carcinoma are present, extensive secretion by the retropubic approach is done before the injection of the radioactive material into the surrounding pelvic fascia and prostatic pedicles. This reduces the amount of tissue which is necessary to irradiate and thus cuts down on the danger of inadequate distribution.—*George W. Chamberlin, M.D.*

Mackay, N. R. Tolerance of the bladder to intracavitary irradiation. *J. Urol.*, Oct., 1956, *76*, 396–400. (From: Radiotherapy Department, The Royal Marsden Hospital, London, S.W. 3, and Institute of Cancer Research, Royal Cancer Hospital, London, England.)

The technique which is used for intracavitary irradiation of bladder tumor is extremely important in the prevention of late bladder fibrosis, as pointed out in this article. In general, intracavitary techniques are useful in the treatment of superficial, diffuse and multiple mucosal neoplasms of the bladder, where a sharp fall-off in depth dose is advantageous. The author prefers the use of radioactive solutions injected into the bladder or into an intravesical thin rubber bag, rather than a solitary central source of irradiation. Solutions, in general, produce a superficial effect which is more desirable than the more penetrating effect from the gamma radiation of the centrally placed source.

The observations and data presented in this article were obtained from cystoscopic examinations and pathologic examination of excised bladders at varying periods following intracavitary irradiation. When irradiation was given by means of a solution of radioactive sodium or bromine with high intensity and using a single dose or fractionated doses at intervals, the bladder reaction was severe with loss of epithelium and subsequent bladder fibrosis.

The optimum technique consisted of relatively low intensity irradiation, prolonged over a period of four days with a total dose of 4,500 to 5,000 gamma r and 1,000 to 1,200 beta r. Twenty patients were treated by this latter method using radioactive bromine and no severe late reactions were found in the bladder.

The author also has treated 20 patients with radioactive colloidal gold injected directly into the bladder for a total dose of 6,000 to 7,000 beta r and 600 to 700 gamma r in five to ten weeks without severe bladder reaction.

The importance of prevention of interstitial radiation cystitis and late fibrosis is emphasized.—*George W. Chamberlin, M.D.*

DePaepe, J.-C., and Ficq, A. A preliminary study of the metabolism of the nucleic acids

and proteins in the cervical epithelium: autoradiographic study of normal and neoplastic tissues. *Brit. J. Radiol.*, March, 1957, *30*, 141–144. (From: Laboratoire de Mythologie Animale, Université libre de Bruxelles, and Clinique Cesar De Paepe, Brussels, Belgium.)

Metabolism in normal and in cancerous cervical epithelium before and after radium therapy is investigated by a track autoradiographic method of following the incorporation of adenine into nucleic acids and phenylalanine into proteins. Biopsies were incubated for one, three and five hours with C^{14} labelled adenine and phenylalanine, fixed, stained and treated with nuclear emulsion. With normal tissue, adenine is first incorporated mainly in the basal and parabasal layers, but after three hours is uniformly distributed. Phenylalanine is localized in the intermediary cells at all times and there is concentration in the nucleolus. It is suggested that the correspondence between the nucleic acids in the basal, and the proteins in the parabasal layer indicates the relation of nucleic acids to protein synthesis.

Before treatment, the radioactivity in neoplastic tissue is greater than normal, but there is considerable variability between regions of the same section and in different cell types. After treatment, the incorporation of adenine is diminished; in 2 out of 10 cases the avidity for adenine was unchanged. This method permits the study of individual surviving cells and it is possible that the inhibition of nucleic acid and protein metabolism may be related to the malignancy of the tumor and so provide a guide to radiation sensitivity.—*Raymond S. Quick, B.S.*

MISCELLANEOUS

Dietz, W. Vergleichende Dosismessungen am Ovar bei Röntgenaufnahmen des Beckens mit "normaler" und Hartstrahltechnik, bei Durchleuchtung des kleinen Beckens mit "normalen" Bedingungen und dem Röntgenbildverstärker. (Comparative dose measurements on the ovary in pelvic roentgenography with normal and high voltage technique and in fluoroscopy of the small pelvis under normal conditions and with an image amplifier.) *Fortschr. a. d. Geb. d. Röntgenstrahlen u. d. Nuklearmedizin*, Oct., 1956, *85*, 456–459. (From: Strahlenabteilung der Univ.-Frauenklinik, Freiburg i. Br., Germany.)

While it has not been definitely proved that the amount of ionizing radiation in diagnostic procedures is able to produce genetic changes or congenital anomalies of the offspring, the radiation effect on the ovaries should, nevertheless, be kept as low as possible. Dose measurements in the vagina showed that when 70 kv. and 100 ma.-sec. were used for a roentgenogram of the pelvis, about 3 times as much radiation could be measured in the vagina as when 125 kv. and 7 ma.-sec. were employed.

When standard fluoroscopy was used, (80 kv., 2 ma., 1 minute), 7 times as much radiation could be detected as when an image amplifier fluoroscope was employed.—*Hans W. Hefke, M.D.*

Harris, John H., Jr., Tuddenham, William J., Stanton, Leonard, Glauser, Frank, and Pendergrass, Eugene P. The development of a chest phantom for use in radiologic dosimetry. *Radiology*, Dec., 1956, *67*, 805–814. (Address: J. H. Harris, Jr., Department of Radiology, Hospital of the University of Pennsylvania, Philadelphia 4, Pa.)

A chest phantom which closely resembles the human thorax (with respect to effective atomic number, mass density, and anatomic detail) has been constructed by the authors. The materials and methods used in construction of the phantom are discussed.

A phantom of the type described in this article is of great practical value for 2 basic reasons: first, to permit the measurement of integral dose received by a patient at 2 mv. compared to that absorbed during a similar examination at the usual diagnostic energy levels; second, for use in the comparative evaluation of diagnostic techniques.

The authors point out that phantoms lacking in anatomic detail, tissue equivalent mass density and atomic number yield valuable information, but often do not accurately simulate conditions which are present in clinical diagnostic and therapeutic procedures.

The comparative evaluation of diagnostic techniques particularly demands a standard, anatomically accurate subject. Obviously, patients cannot be used for this purpose on account of the danger of overexposure, the marked variation in thoracic anatomy from patient to patient, and the inability to place test objects at desired sites within the chest. The use of a properly constructed phantom eliminates these problems. The insertion of a blood-equivalent cast of the heart and pulmonary vascular system and the representation of the other mediastinal structures in their proper anatomic relationships by tissue-equivalent material provide the anatomic detail so necessary for the objective investigation of diagnostic techniques. Test objects placed in the mediastinum, for example, will be surrounded and obscured by structures that normally obscure lesions in this area. In the development of a technique to better demonstrate these lesions, the conditions involved will approximate those found in man.

Absorbed-dose and depth-dose measurements cannot be made using patients as standards. This is particularly true in the comparison of the dosage received in similar diagnostic procedures at various energy levels and in the different forms of therapeutic radiology. By placing ionization chambers

in the lumen of the trachea or stem bronchus of the phantom, direct comparison of the dosage delivered to a point in the mediastinum by rotational and multiple portal therapy is possible. Chambers placed in the lung fields and behind ribs of the phantom will give a more reasonable estimation of the dose delivered to the pulmonary parenchyma and the effect of bone upon the penetrating beam.

A study of the original article is recommended for those interested in investigative research in which chest phantoms are used.—*A. Ralph Watson, M.D.*

Jacobson, Lillian E., and Knauer, Isabelle S. Correction factors for tumor dose in the chest cavity due to diminished absorption and scatter in lung tissue. *Radiology*, Dec., 1956, *67*, 863–876. (Address: L. E. Jacobson, 27 S. Ninth St., Newark 7, N. J.)

An investigation was undertaken to determine correction factors for the tumor dose of irradiation in the lung and in the mediastinum. Correction factors were determined from measurements obtained on a phantom man for 200 kv., 400 kv., and Co^{60} radiations for single and multiple ports and for rotation therapy with Co^{60}.

Masonite pressdwood was used as a substitute for muscle, and cork as a substitute for lung. The values for both of these materials were found to correspond sufficiently well to those for lung and muscle to permit their use for absorption measurements. Ionization measurements were made with either a Victoreen 25 r or 250 r chamber. The dose was measured at the center of the entrance port of the "treated volume" and of the exit port.

For 200 kv. roentgen rays, no correction is necessary for tumors located anywhere in the lung or in the mediastinum if treatment is given through either 2 or 3 ports. If the tumor is located in the mediastinum and treated through 6 ports, the correction factor is 1.25.

For 400 kv. roentgen rays, the correction factor is 1.15 for 2 or 3 port therapy if the lesion is located in the central portion of a lung. For a mediastinal lesion treated through 6 ports, the correction factor is 1.20.

The correction factor for Co^{60} gamma radiation is 1.15 for rotation therapy, or 2 or 3 fixed ports, with the lesion anywhere in the chest cavity except the mediastinum. For a mediastinal lesion treated through 3 ports, the correction factor is 1.20.

Each factor, when multiplied by the tumor dose as calculated from depth-dose tables, gives the dose received at the lung or mediastinal lesion.—*A. W. Sommer, M.D.*

Ehrlich, Margarete. Disaster monitoring with amateur photographic film and dental x-ray film. *Radiology*, Feb., 1957, *68*, 251–254. (Address: Radiological Equipment Section, National Bureau of Standards, Washington 25, D. C.)

If an atomic disaster were to strike an urban community, it would be of great importance to have some means of reconstructing, at least approximately, the pattern of radiation dose distribution over the different sections of that community. Two recent publications deal with the problem of radiological monitoring with amateur and commercial photographic roll films. The result of studies to further investigate this type of disaster monitoring is here presented. The data were obtained in a series of laboratory tests and in an actual field exposure to the prompt radiation from the detonation of a nuclear device during the 1955 series of atomic tests at the Nevada Test Site.

The studies revealed that amateur roll films could be used for monitoring if they had been exposed in their original packages, provided the dose interpretation was made from the density on areas not obliterated by the image of the central metal spool, and located in the outer third of the film length. Examination of dental films exposed in large boxes containing 100 or more films was found to be undesirable, mainly because of the filtering action of the lead backing of dental film packets.

Since there was considerable variation in results following different film processing techniques, it is imperative that all films be processed in one laboratory, and if possible, all films be processed simultaneously, calibration films being included with the unknown samples.—*A. R. Watson, M.D.*

OSCAR V. BATSON
Caldwell Lecturer, 1956